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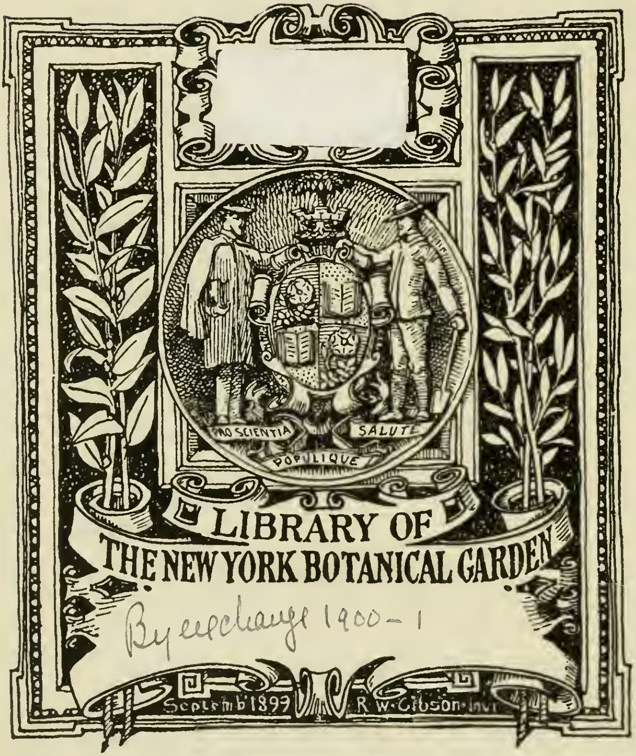
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[Grass and Forage Plant Investigations.]

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STUDIES
ON
AMERICAN GRASSES.

THE NORTH AMERICAN SPECIES OF CHÆTOCHLOA.

BY

F. LAMSON-SCRIBNER and ELMER D. MERRILL.

ISSUED MARCH 8, 1900.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Agrostology,
Washington, D. C., January 15, 1900.

Sir: I have the honor to transmit herewith and recommend for publication as Bulletin No. 21 of this Division, and under the general title of "Studies on American Grasses," a revision of the North American species of *Chætochloa*.

In our manuals of the plants of the northern United States four species of *Chætochloa* are described, all introduced, three being common weeds, the fourth an occasional escape from cultivation. In Chapman's Southern Flora two additional and presumably native species are enumerated. In the paper here presented 28 North American species are described, 23 of which are natives of this continent. Six of the species enumerated are published here for the first time.

Acknowledgments are due Dr. B. L. Robinson, curator of the Gray Herbarium, for the loan of specimens and assistance in looking up authorities, etc., and to J. H. Burchell, of the Kew Herbarium, for assistance in the determinations by making comparisons with type material.

Respectfully,

F. Lamson-Scribner,
Agrostologist.

Hon. James Wilson,
Secretary of Agriculture.

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THE NORTH AMERICAN SPECIES OF CHÆTOCHLOA.

INTRODUCTION.

The North American species of *Chætochloa* have long been unsatisfactorily identified, and the present revision is offered in the hope of clearing up much of the existing confusion in this genus. It was at first proposed to consider only those species native of or introduced into the United States, but as the Mexican and West Indian species were found to be in an even more unsatisfactory condition than those of the United States, it seemed advisable to include such of these species as were represented in the material at hand.

In North America there are 28 species of *Chætochloa*, 6 of which are here published for the first time. Of these 28 species, 23 are native of North America, the remaining 5 having been introduced from Europe, of which 3 are cosmopolitan weeds found in the temperate regions of both hemispheres.

From an economic standpoint the genus takes high rank through the extensive cultivation of *C. italica*, various forms of which, under the names of millet, Hungarian grass, etc., are widely cultivated in this country as soiling or forage crops, and are among the oldest cultivated crops of the world, record having been found of its cultivation in China as early as 2700 B. C. In Europe its cultivation dates from prehistoric times, as the grain is found in abundance in the débris of the Lake Dwellings of the Stone Age in Switzerland.

The species are for the most part readily distinguished, except in the group represented by *C. imberbis*, which is extremely variable and is found in the warmer regions in both hemispheres. In general the details of the spikelets in this group are very similar, the variation being chiefly in the length and color of the panicles and setæ and in the vegetative characters. *C. gracilis* and *C. purpurascens* are here recognized as valid species, as they have certain constant characters by which they can be readily distinguished from related species. *C. macrostachya*, originally described from Mexican material and since credited to Asia and Australia, is confined to America, the Asiatic forms referred to this species are now referred to CHÆTOCHLOA FORBESIANA (Nees) n. comb. (*Panicum forbesianum* Nees) and the Australian form, which is very distinct from *C. macrostachya*, is here proposed as a new species. *C. composita*, a common southwestern grass, has long been referred by botanists to *C. caudata* and *C. setosa*, from both of which it is very distinct.

"The name *Setaria*, which has been taken up by many botanists for a number of well-known weedy grasses with dense, spike-like, bristly panicles, was first applied by Beauvois (Flora Oware et Benin.) to a species of *Pennisetum*. At an earlier date the name was employed by Acharius to designate a genus of lichens. According to all rules of botanical nomenclature, this last fact renders the name untenable for designating a genus of flowering plants; and were this not the case, its first application to a species of *Pennisetum* placed it at once among the synonyms, which, according to recent rulings, would debar its further use. Some botanists have referred the grasses in question to the genus *Panicum*, from the species of which they differ only in the presence of setæ issuing from the pedicels of the spikelets below their articulation. It is this character, combined with their inflorescence, which led them to be separated from *Panicum*, in which genus the earlier described species were first placed. The taking up of the name *Chamæraphis*, a genus established by R. Brown upon certain Australian and south Asiatic grasses having spikelets like those of *Panicum*, but with the partial rachis of the inflorescence produced into long awn-like points beyond the insertion of the upper or only spikelet, appears to have been ill advised, and the more recent adoption of *Ixophorus* for *Setaria* is equally so. The latter genus, *Ixophorus*,[1] possesses well-marked characters of generic value, and the same is true of *Chamæraphis*. Neither of these names can be taken up for *Setaria*, unless they are used in a very broad sense to include all the species of *Panicum* thrown by Steudel into the section *Setaria;* that is, those species, as Schlechtendal states it, having "*spiculæ in axibus inflorescentiæ variæ evolutis pedicellatæ sessilesve, axium sterilium, setas æmulantium majore minoreve copia cum spiculis nascente.*" This would bring together a heterogeneous assemblage of species, the natural result of the adoption of characters too artificial, which, with our present ideas of genera, would be much more easily and more systematically treated if divided into genera upon more natural and genetic characters. While our Setarias, so called, might, under a broad conception of the genus *Panicum*, be referred to it, they seem to form a well-marked group, as indicated by the characters noted above, which it seems best to maintain as a genus, under the new name *Chætochloa*."[2]

CHÆTOCHLOA Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 38 (1897). *Setaria* Beauv. Agrost. 113 (1812), in part, not Fl. Oware et Benin. **2**: 80 (1807), nor Acharius (1798). *Chamæraphis* Kuntze in part, not R. Br. *Ixophorus* Nash (1895), not Schlecht. (1861–62).

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[1] Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 1. (1897.)

[2] Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 38. (1897.)

Spikelets hermaphrodite, usually 1-flowered. Glumes 4, the outer 3 membranous, the third often subtending a hyaline palea and rarely a staminate flower, the fourth or flowering glume chartaceous, smooth or transversely rugose, inclosing a palea of similar texture. Stamens 3. Styles distinct, elongated; setæ persistent, single or in clusters below the articulation of the rachilla; stigmas plumose. Grain free, inclosed within the glumes and palea.

Annual or perennial grasses with erect culms, flat leaves, and dense, cylindrical, or somewhat open bristly panicles.

Species about 40 in the tropical and more temperate regions of both hemispheres.

ANALYTICAL KEY TO THE SPECIES.

1. Setæ 5 to 16 at the base of each spikelet, involucrate 2
1. Setæ 1 to 3 at the base of each spikelet, not involucrate 5
2. Annual; setæ short, tawny-yellow .... 1 **C. glauca.**
2. Perennial, from short creeping rootstocks 3
3. Setæ short, once or twice as long as the spikelets; panicles slender 4
3. Setæ generally elongated, spreading; panicles thick .... 2 **C. imberbis.**
    (*a*) Setae very long, yellow or purple .... var. **penicillata.**
    (*b*) Plants not cæspitose; culms naked and wiry at the base; spikelets purplish .... var. **perennis.**
    (*c*) Plants robust, glaucous; culms erect; leaves long, rigid, erect; panicles pale green, elongated .... var. **streptobotrys.**
    (*d*) Plants robust; culms geniculate; panicles 6 to 12 cm. long, yellowish .... var. **geniculata.**
4. Leaves narrow, linear, elongated; panicle very slender, pale .... 4 **C. gracilis.**
4. Leaves linear-lanceolate, short; panicle thicker, usually purplish .... 3 **C. purpurascens.**
5. Second glume equaling the flowering glume in length 6
5. Second glume shorter than the flowering glume 15
6. Setæ antrorsely scabrous 7
6. Setæ retrorsely scabrous, wholly or in part 13
7. Flowering glume strongly transversely undulate-rugose .... 12 **C. longipila.**
7. Flowering glume smooth, or at least only punctate or striate, not rugose 8
8. Panicle dense, cylindrical; branches short, approximate, densely flowered 9
8. Panicle lax; branches remote, generally elongated, few-flowered 12
9. Flowering glume very smooth, glossy; plants robust, 18 to 36 dm. high .... 11 **C. magna.**
9. Flowering glume more or less roughened, not glossy; plants less than 18 dm. high 10
10. Axis of the inflorescence scabrous; branches subverticillate .... 8 **C. ambigua.**
10. Axis of the inflorescence pilose; branches alternate 11
11. Panicles 2 to 8 cm. long, 1 cm. or less thick; spikelets 2 mm. long, much exceeded by the usually green setæ .... 9 **C. viridis.**
11. Panicles 5 to 20 cm. long, 1 to 3 cm. thick; spikelets about 2.3 mm. long, equaled or exceeded by the usually purple setæ; cultivated .... 10 **C. italica.**
    (*a*) Culms 3 to 9 dm. high; panicle 1 cm. in diameter; setæ long, purple, rarely green .... var. **germanica.**
12. Spikelets 3 mm. long .... 24 **C. villosissima.**
12. Spikelets 2 mm. long .... 25 **C. grisebachii.**
13. Setæ retrorsely scabrous above, antrorsely scabrous at the base; leaves pubescent .... 7 **C. scandens.**
13. Setæ retrorsely scabrous throughout; leaves scabrous 14
14. Panicles 1.5 to 3 cm. long, 1 cm. thick, purplish .... 5 **C. brevispica.**

14. Panicles 5 to 18 cm. long, tapering to the obtuse apex, green, rarely purplish .... 6 **C. verticillata.**
15. Spikelets 3 mm. long 16
15. Spikelets less than 3 mm. long 18
16. Leaves smooth or scabrous 17
16. Leaves pilose-pubescent .... 24 **C. villosissima.**
17. Leaves lanceolate, 10 to 20 mm. wide; panicle loose; branches elongated, few-flowered .... 23 **C. macrosperma.**
17. Leaves linear, glaucous, 2 to 5 mm. wide; panicle subspiciform; branches densely flowered .... 18 **C. composita.**
18. Inflorescence spike-like, dense; branches very short, approximate 19
18. Inflorescence lax, interrupted; branches more or less elongated 24
19. Flowering glume strongly transversely undulate-rugose 20
19. Flowering glume smooth or only finely transversely wrinkled 23
20. Leaves smooth or scabrous .... 13 **C. corrugata.**
    (*a*) Spikes 5 to 7 cm. long; setæ usually purplish, spreading .. var. **parviflora.**
20. Leaves pubescent or pilose 21
21. Leaves lanceolate, acute, 12 to 15 mm. wide; setæ long .... 21 **C. latifolia.**
    (*a*) Leaves 10 mm. wide or less; setæ short .... var. **breviseta.**
21. Leaves linear or linear-lanceolate, about 5 mm. wide 22
22. Culms pilose with scattered hairs; fertile palea nearly plane .... 15 **C. hispida.**
22. Culms smooth; fertile palea strongly convex .... 14 **C. gibbosa.**
23. Leaves pilose; plants 2 to 3 dm. high .... 16 **C. leucopila.**
23. Leaves smooth or scabrous, glaucous; plants robust, 4 to 9 dm. high. .... 18 **C. composita.**
24. Setæ antrorsely and more sparingly retrorsely scabrous .... 17 **C. onurus.**
24. Setæ antrorsely scabrous only 25
25. Flowering glume very strongly transversely undulate-rugose 26
25. Flowering glume smooth or only finely transversely wrinkled 27
26. Leaves and rachis pilose .... 21 **C. latifolia.**
26. Leaves and rachis scabrous .... 22 **C. liebmanni.**
    (*a*) Branches of the panicle very short; leaves 1 dm. long or less, 8 to 10 mm. wide .... var. **pauciflora.**
27. Leaves linear 28
27. Leaves lanceolate or linear-lanceolate 29
28. Leaves glaucous; panicle pale, obtuse at the apex .... 18 **C. composita.**
28. Leaves pubescent; panicle long-attenuate at the apex .... 27 **C. caudata.**
29. Panicle subcylindrical; branches densely flowered 30
29. Panicle more lax; branches loosely few-flowered 31
30. Margins of the sheaths smooth; setæ short .... 20 **C. rigida.**
30. Margins of the sheaths ciliate-fringed; setæ long, spreading .... 19 **C. macrostachya.**
31. Flowering glume manifestly transversely wrinkled 32
31. Flowering glume smooth or only pitted or striate .... 25 **C. grisebachii.**
    (*a*) Plants densely cæspitose, less than 1 dm. high .... var. **mexicana.**
    (*b*) Plants robust, 5 to 8 dm. high; branches of the panicle elongated, spreading, the lower ones 2 to 3.5 cm. long .... var. **ampla.**
32. Panicle long-attenuate at the apex; branches strict, erect; leaves pubescent .... 28 **C. setosa.**
32. Panicle obtuse at the apex; branches spreading; leaves smooth or pilose .... 26 **C. polystachya.**

A. *Setæ 5 to 16, involucrate.*

**Annual.*

1. **Chætochloa glauca**[1] (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul **4**: 39 (1897). *Panicum glaucum* L. Sp. Pl. 56 (1753). *Setaria glauca* Beauv. Agrost. 51 (1812). *Chamæraphis glauca* Kuntze Rev. Gen. Pl. **2**: 767 (1891). *Ixophorus glaucus* Nash Bul. Torr. Bot. Club **22**: 423 (1895). (Fig. 1.)

An erect or ascending somewhat cæspitose, glaucous annual 3 to 12 dm. high, with flat, lanceolate or linear-lanceolate leaves, and dense, bristly, cylindrical, spike-like, yellowish panicles 2 to 10 cm. long. Culms branching at the base, geniculate, compressed, glabrous; nodes brown, smooth; sheaths glabrous, loose, compressed, margins hyaline, smooth; ligule short, ciliate; leaf blades 0.5 to 1.5 dm. long, 4 to 8 mm. wide, long-acuminate, glaucous, nearly glabrous, or scabrous on the upper surface and margins, generally pilose, with scattered long white hairs at the base. Panicles dense, linear-ovate, obtuse, about 1 cm. in diameter; rachis angular, pubescent; setæ involucrate, 5 to 12 at each spikelet, straight, or subflexuous, unequal, antrorsely scabrous, yellow, 3 to 8 mm. long. Spikelets broadly ovate, 3 mm. long, 2 mm. broad, acute or obtuse; first glume one-third to one-half as long as the spikelet, acute, 3-nerved; second glume one-half to two-thirds as long as the spikelet, broadly ovate, acute, 5-nerved, the mid-nerve excurrent, the lateral ones anastomosing with it; third glume 5-nerved, equaling the flowering glume, subtending a broadly-lanceolate, hyaline palea nearly its own length; flowering glume broad-ovate, acute, 2.5 mm. long, striate, transversely undulate-rugose, the inclosed palea broad, convex at the base, concave above, transversely striate.

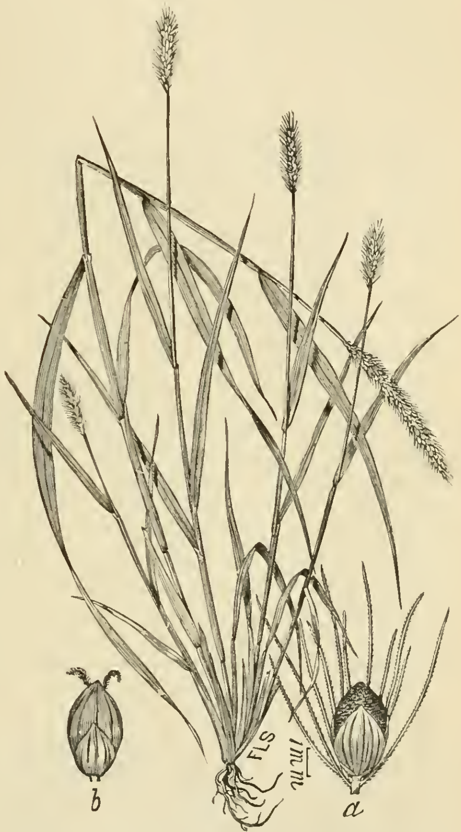

Fig. 1.—*Chætochloa glauca:* *a*, view of the spikelet showing the setæ; *b*, spikelet showing the first and third glumes.

In waste places and cultivated grounds widely distributed in North America. Naturalized from Europe. July–September.

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[1] Chætochloa apiculata sp. nov.

An erect, cæspitose, perennial (?), 2 to 4 dm. high, with rather rigid leaves, large spikelets, and long, erect setæ. Culms slender, slightly geniculate and generally much branched at the base, glabrous or slightly scabrous; nodes smooth; sheaths

Specimens examined.—*Ottawa:* Macoun 1884. *Maine:* Rumford, Parlin 1889; Auburn, Merrill 1898. *New Hampshire:* Jaffrey, 284 Robinson 1897. *Massachusetts:* Great Barrington, Pollard 1894; South Hadley, Clark 1887. *Connecticut:* South Glastonbury, 25 Wilson 1892. *New York:* Oxford, Coville 1884; New York, Kenyon 1889. *New Jersey:* Weehawken, Van Sickle 1895. *Pennsylvania:* Conewago, Small; Philadelphia, Smith; Easton, Porter 1896. *Delaware:* 146 Commons 1897. *District of Columbia:* Vasey 1885. *Ohio:* Ricksecker 1894. *Michigan:* Keweenaw Co., 537 Farwell 1886. *Tennessee:* Knoxville, Scribner. *Iowa:* Fayette Co., Fink 1894; Ames, 180 Ball 1896. *Kansas:* Manhattan, Bassler, 1883; Riley Co., 575 Norton 1895. *Missouri:* 266 Eggert 1886. *Wisconsin:* Oshkosh, Random 1896. *South Dakota:* Bellefourche, 366 Griffiths 1897; Redfield, 221 Griffiths 1897; Frankfort, 54 Griffiths 1897. *North Carolina:* Magnetic City, Wetherby 1895. *Alabama:* McCarthy 1888. *Louisiana:* Ascension, 1409 Combs 1898; Rayville, 23*a* Ball 1898; Calhoun, 44 Ball 1898; Shreveport, 97 Ball 1898.

***Perennial.*

2. **Chætochloa imberbis** (Poir.) Scribn.; U. S. Dept. Agr., Div. Agros. Bul. **4**: 37 (1897). *Panicum imberbe* Poir. Encycl. Suppl. **4**: 272 (1817). *Panicum lævigatum* Muhl. in Elliott Sk. Bot. S. Car. & Ga. **1**: 112 (1817). *Chætochloa lævigata* Scribn. *Chætochloa perennis* (Curtiss) Bicknell Bul. Torr. Bot. Club **25**: 107 (1898).

An erect or ascending, more or less caespitose, glabrous perennial, 3 to 7 dm. high, from short, creeping rootstocks, with linear-lanceolate leaves and dense, exserted, cylindrical panicles. Culms slender, compressed, generally somewhat geniculate at the base, scabrous below the panicle, otherwise very smooth; nodes glabrous; sheaths glabrous, compressed, the lower much longer than the internodes, imbricate, distichous, smooth on the hyaline margins; ligule ciliate, with very short hairs; leaf-blades 1 to 3 dm. long, 3 to 7 mm. wide, scarcely narrowed at the base, long-tapering to the apex, slightly scabrous on the upper surface and margins, glabrous below, sometimes with a few long white hairs at the throat. Panicles dense, spike-like, 2 to 5 cm. long, nearly 1 cm. in diameter, exclusive of the setæ; rachis angular, pubescent; branches short, contiguous, 1 or rarely 2-flowered; setæ 8 to 12, involucrate, spreading, 5 to 10 mm. long, unequal, slender, pale, yellowish or sometimes purplish, finely antrorsely scabrous. Spikelets ovate, acute, 2 to 2.5 mm. long; first glume about one-third as long as the spikelet, ovate, acute or obtuse, 3-nerved; second glume one-half to two-thirds as long as the spikelet, ovate, acute, 5 to 7 nerved, the mid-nerve excurrent, the lateral ones anastomosing or abruptly vanishing in the hyaline margin; third glume equaling the flowering glume and slightly inclosing it by

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about equaling the nodes, striate, glabrous, margins hyaline, smooth; ligule very short, ciliate-fringed; leaf-blades plane or becoming involute in drying, 1 to 3 dm. long, 3 to 6 mm. wide, long, slender, acuminate, scabrous, usually bearded with few long white hairs at the throat and sparingly pilose. Panicles pale, dense, cylindrical, spiciform, 2 to 5 cm. long, 5 to 6 mm. in diameter; rachis pubescent; branches very short, generally 1-flowered; setæ 6 to 10, involucrate, spreading-erect, 1 to 1.5 cm. long, antrorsely scabrous, pale. Spikelets 3 to 3.5 mm. long, broadly ovate, acute, apiculate; first glume one-half as long as the spikelet, narrowly cordate, acuminate, 5-nerved; second glume about as long as the spikelet, 7-nerved, acute, apiculate; third glume equaling the spikelet, sulcate, 7-nerved, subtending a lanceolate, hyaline palea nearly its own length; flowering glume broadly ovate or rotund-ovate, acute, apiculate, strongly transversely undulate-rugose, the inclosed palea nearly smooth, plane.

Australia.

Type specimen collected by F. von Mueller, Victoria River, Queensland. Distributed under the name *Setaria glauca* Beauv., but at once distinguished by its narrower leaves, long setæ, larger spikelets, longer first and second glumes, and more strongly rugose flowering glume, all the glumes being prominently apiculate.

its infolded margins, acute, apiculate, 5-nerved, sulcate, subtending a broad, hyaline palea of its own length; flowering glume elliptical-ovate, acute, striate, finely transversely rugose for its whole length, the inclosed palea slightly convex at the base, plane or concave above.

In moist soil, New Jersey to Florida and Texas, north to Kansas and Missouri; Mexico, West Indies, South America. May–October.

Specimens examined.—*New Jersey:* Holmes 1890. *North Carolina:* Biltmore, 6026*a* Biltmore Herb. 1898; no locality, McCarthy 1889. *South Carolina:* Santee Canal, Ravenel. *Georgia:* Augusta, 200 Kearney 1895. *Florida:* Duval Co., 3614 Curtiss 1883; Jacksonville, 4745 Curtiss 1894, 5411Curtiss 1895, 19 Combs 1898; Bay Head, 659 Combs 1898; Cedar Key, 775 Combs 1898; Eustis, 566 Nash 1894. *Alabama:* Mobile, 42, 58 Kearney 1895. *Mississippi:* Chandeleur Island, Tracy 1897; Agricultural College, 34 Kearney 1896; Starkville, 22 Kearney 1896; *Louisiana:* New Orleans, 343 Kearney 1896; Oberlin, 218 Ball 1898; Pointe-à-la-Hache, 54 Langlois 1883. *Indian Territory:* Verdigris, 744 Bush 1894. *Texas:* Hampstead, 840 Hall 1872; Bexar Co., 207 Jermy; Pinto Creek, Kinney Co., 82 Hill 1895; Kerrville, 1889 Heller 1894; Home Canyon, 423 Carleton 1891; Houston, 15 Engelmann 1842; Ennis, Smith 1897; Dallas, Reverchon 1875; without locality, C. Wright 1849; Nealley 1884; Reverchon 1879, 1883. *New Mexico:* Drummond, 984 Fendler 1847. *West Indies:* St. Thomas, 185 Eggers 1880. *Cuba:* 3888 Wright 1865. *Puerto Rico:* 208 Sintenis 1884. *Mexico:* 536 Gregg 1848–49; Cuicatlan, 1652 Nelson 1894; Guadalajara, 246 Palmer 1886. *Lower California:* San Jose del Cabo, 15 Brandegee 1890.

Very readily distinguished from *C. glauca* (L.) Scribn., to which it has been referred as a variety and with which it is confused, by its perennial roots, longer, glabrous leaves, longer setæ and smaller spikelets.

This variable species has long passed under the name *Setaria lævigata*, but from careful consideration it would seem that *imberbis* is the proper name. Trinius (Icon. t. 196, Fig. A) says in his description of the plate that Fig. A is *Setaria gracilis* Kunth, which can hardly be a synonym of *Panicum imberbe* Poir.,[1] but below in referring to the plate he calls Fig. A *Setaria imberbis;* hence the confusion regarding this species. Poiret in his original description says that the specimens on which he based this species were from Carolina, Puerto Rico, and Brazil, and that they differed from *Panicum glaucum* of Europe not only in having the bristles of the involucre longer, but also by the leaves being destitute of hairs at the apex of the sheaths.

Chætochloa gracilis, the slender form of Trinius t. 196, does not grow naturally north of Texas, and, moreover, it can not be Poiret's *Panicum imberbe*, as is seen from the original description.

CHÆTOCHLOA IMBERBIS PENICILLATA (Nees) n. comb. *Panicum penicillatum* Nees. Agrost. Bras. 242 (1829). (Fig. 2.)

An erect or ascending perennial, sometimes rooting at the lower nodes, with panicles 3 to 12 cm. long, and long, widely spreading yellow, brown, or purplish setæ, otherwise as in the type.

In fields and pine woods Georgia to Texas, Mexico, and South America.

Specimens examined.—*Georgia:* Augusta, 227 Kearney 1895; Savannah, 186 Kearney 1895. *Florida:* Waldo, 702 Combs 1898; Lake City, 83, 179 Combs & Rolfs 1899; Monticello, 346 Combs 1898; Old Town, 877 Combs 1898; Quincy, 396 Combs 1898; Apalachicola, 116 Kearney 1895. *Louisiana:* Pointe-à-la-Hache, 55 Langlois 1880; Calhoun, 41 Ball 1898. *Mississippi:* Ocean Springs, 1105. Pollard 1896; Biloxi, 217 Kearney 1896. *Texas:* Ennis, J. G. Smith 1897, without locality; Hall 1872; Nealley 1887.

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[1] Cujus syn. vix erit *P. imberbe* Poir.

CHÆTOCHLOA IMBERBIS PERENNIS (Hall) n. comb. *Setaria perennis* Hall, Trans. Kans. Acad. Sci. **13**: 102 (1893). *Chætochloa versicolor* Bick. Bul. Torr. Bot. Club. **25**: 105, pl. 328 (1898).

A slender, scarcely tufted, loose form, 6 to 12 dm. high, with very slender wiry culms, which are naked below, long, narrow leaves, and rather slender, long-exserted panicles, 2.5 to 7 cm. long. Spikelets generally purplish. Setæ very slender, 6 to 10 mm. long, yellowish-green or purple.

In brackish marshes, along the coast from Connecticut to Florida and Mississippi, and in alkaline and saline bottoms, Kansas and Indian Territory. June–September.

SPECIMENS EXAMINED.—*Maryland:* Bay Ridge, Scribner 1897; Takoma Park, Williams 1899. *Florida:* Barstow, 1232 Combs 1898; Homosassa, 924, 969 Combs 1898; Jacksonville, 13 Combs 1898; Lake City, 79 Combs 1898; Madison, 237 Combs 1898; Cedar Key, 794 Combs 1898; Ellzey, 826 Combs 1898. *Louisiana:* Alexandria, 185 Ball 1898. *Mississippi:* Biloxi, Tracy 1898. *Indian Territory:* Bigelow 1853–54. *Kansas:* Comanche Co. 1544 Hitchcock 1896; Hutchinson, 2 Smyth 1890.

This form is not worthy of specific rank, as all gradations are found between it and the typical *C. imberbis.* The characters used by Bicknell in separating his species, such as the longer and fewer nerved glumes, absence of hairs at the base of the leaves, purplish flowering glume, etc., are not constant, but are found to be extremely variable.

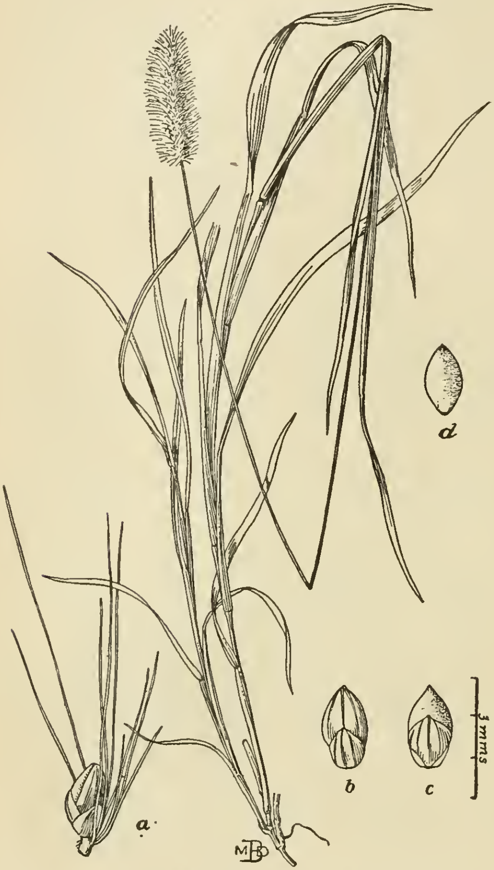

FIG. 2.—*Chætochloa imberbis penicillata:* *a*, spikelet showing the setæ; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

CHÆTOCHLOA IMBERBIS GENICULATA (Lam.) n. comb. *Panicum geniculatum* Lam. Encycl. **4**: 727 (err. typ. 737) (1797). *Setaria geniculata* Beauv. Agrost. 51 (1812). *Chamæraphis glauca geniculata* Beal, Grasses of N. Am. **2**: 156 (1896).

A stout, glaucous form, 5 to 10 dm. high, with geniculate culms, broader leaves, and elongated panicles 6 to 12 cm. in length; leaf-blades 1 to 3 dm. in length, 5 to 8 mm. wide. Panicles erect, yellowish, 5 to 8 mm. in diameter. Spikelets as in the type.

West Indies, Mexico, South America.

Specimens examined.—*Mexico:* Durango, 378, 471, 539 Palmer 1896; Rio Hondo, 3156 Holway 1898; Jalisco, Guadalajara, 293 Palmer 1886; Oaxaca, 5723 Galeotti 1840; 342 Conzatti & Gonzalez 1897; 710 Nelson 1894; Coahuila, 431 Pringle 1885; Guanajuato, Dugès 1893; Orizaba, 631 Botteri, 2639 Bourgeau, 1865–66; 115 Seaton 1891; San Luis Potosi, 1041 Schaffner 1876; without locality, Ghiesbreght 1842. *Cuba:* 3472 Wright 1860–64. *St. Croix:* 243 Ricksecker 1896. *Puerto Rico:* 6861 Sintenis 1887.

Fournier[1] makes a variety *latifolia* of this species (*Setaria geniculata*), based on 2639 Bourgeau and 5723 Galeotti, both of which are represented in the Gray Herbarium. In these specimens none of the leaves exceed 8 mm. (4 lines) in width. In the original description the leaves are described as "*longues, larges du trois à quartre lignes, planes, glabres,*" etc. In other specimens cited by Fournier as representing the type 350 Liebmann and Ghiesbreght 1842, represented in the United States National Herbarium, the plants are depauperate, with narrow leaves, not exceeding 6 mm. wide, and shorter, narrower spikes. In Jaquin[2] the description and plate represent the type as having broad leaves and thick, elongated spikes; hence it would seem that Fournier had a wrong idea of the type, which is best represented by his variety *latifolia*.

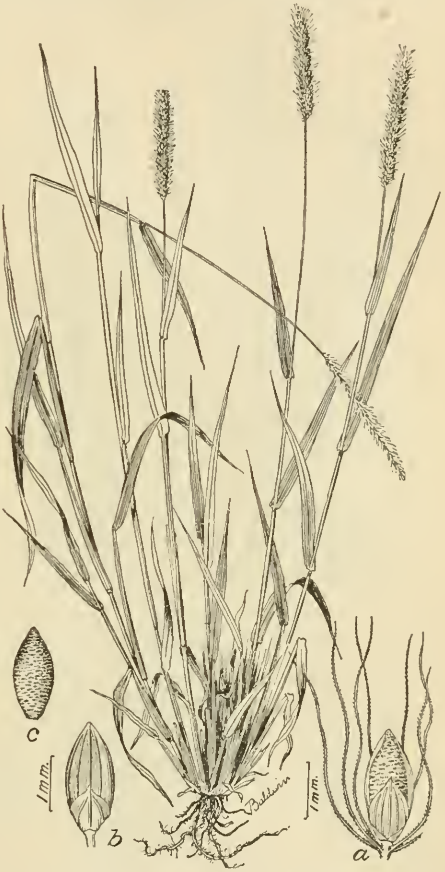

Fig. 3.—*Chætochloa purpurascens: a*, spikelet showing the setæ; *b*, spikelet showing the first and third glumes; *c*, flowering glume, dorsal view.

CHÆTOCHLOA IMBERBIS STREPTOBOTRYS (Fourn.) n. comb. *Setaria streptobotrys* Fourn. Mex. Pl. Enum. Gram. 47 (1886).

A pale, glaucous form, 4 to 6 dm. high, with stout, erect culms, linear-lanceolate, glaucous, and nearly glabrous leaves and pale-green panicles, 6 to 10 cm. long, about 6 mm. in diameter; setæ pale-green, spreading. Closely related to var. *geniculata*.

Mexico.

Specimens examined.—*Mexico:* Oaxaca, 342 Conzatti & Gonzalez 1897; Coahuila, 431 Pringle 1885; Durango, 378, 381, 471 Palmer 1896.

3. **CHÆTOCHLOA PURPURASCENS** (H. B. K.) n. comb. *Setaria purpurascens* H. B. K. Nov. Gen. & Sp. Pl. **1**: 110 (1815). (Fig. 3.)

An erect or ascending, cæspitose perennial, 1 to 6 dm. high, from short, creeping rootstocks, with short, lanceolate or linear-lanceolate leaves, short setæ, and dense, cylindrical, usually purplish, spiciform panicles, 1 to 5 cm. in length. Culms slender, branching, and geniculate at the base, glabrous; nodes smooth; sheaths loose, striate, glabrous, shorter than the internodes, margins smooth; ligule very short, ciliate; leaf-blades 5 to 10 cm. long, 4 to 6 mm. wide, scabrous on both sides and on the cartilaginous margins, sometimes nearly smooth beneath, not narrowed at the cordate base, acute or acuminate. Panicles about 5 mm. in diameter, somewhat exserted; rachis angular, pubescent; branches very short, 1 or 2 flowered, approximate; setæ 5 to 10, short, unequal, involucrate, 3 to 8 mm. long, flexuous, green or purplish, often barely exceeding the spikelets, antrorsely scabrous. Spikelets ovate, acute, 2 mm. long; first glume ovate, acute, 3-nerved, one-third as long as the spikelet; second glume ovate, acute or obtuse, about one-half as long as the spikelet, 5-nerved, mid-nerve excurrent, the lateral ones anastomosing or vanishing in the hyaline margins; third glume equaling the flowering glume, 5-nerved, sulcate, subtending a broadly ovate, hyaline palea of its own length; flowering glume ovate, acute, transversely undulate-striate for its whole length, the inclosed palea equaling it in length, striate, plane.

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[1] Mex. Pl. Enum. Gram. 46.

[2] Eclogæ Gram. t. 27, *Pennisetum geniculatum.*

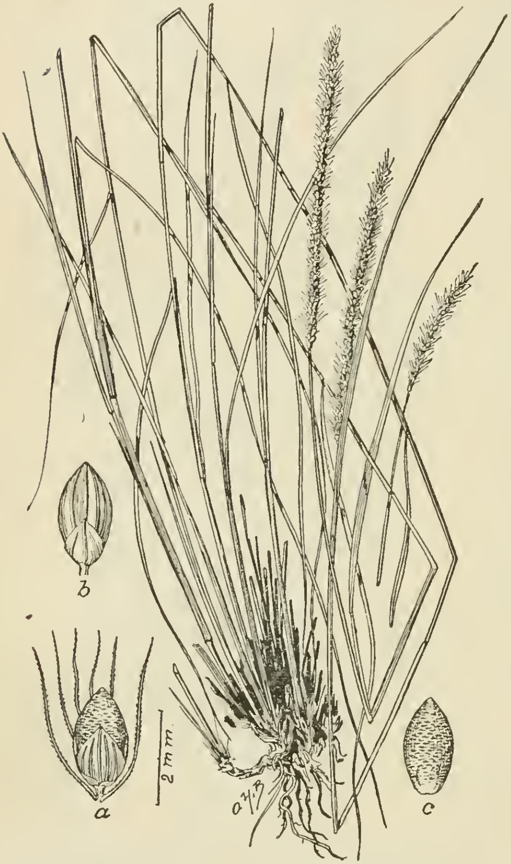

FIG 4.—*Chætochloa gracilis:* *a*, spikelet showing the setæ and second glume; *b*, spikelet showing the first and third glumes; *c*, flowering glume, dorsal view.

Texas to Mexico, West Indies, Central and South America.

SPECIMENS EXAMINED.—*Texas:* San Diego, Smith 1897; Bexar Co., 207 Jermy; Dallas, Reverchon 1876. *Cuba:* 3472 Wright 1865. *Mexico:* Chiapas, 3023*a*, 3336 Nelson 1895; City of Mexico, 7 Holway 1896; 3126 Holway 1898; Orizaba, 114, 247 Seaton 1891; 33 Nelson 1894; Plunia, 2482 Nelson 1895; Puebla, Nelson 1893; Chinantha, 350 Liebmann 1841, cited by Fournier[1] under *Setaria geniculata;* valley of Mexico, 231 Bourgeau 1865–66; Colipa, 360 Liebmann 1841, cited by Fournier under *Setaria flava.*

An extremely variable species, at once distinguished from the closely related *C. gracilis* by its shorter, lanceolate or linear-lanceolate leaves and thicker, usually purplish spikes. The form which Fournier referred to *Setaria flava* Kunth, differs from the typical material only in having the panicle pale instead of purple, or at least only the spikelets being tipped with purple.

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[1] Mex. Pl. Enum. Gram. 45.

4. **CHÆTOCHLOA GRACILIS** (H. B. K.) n. comb. *Setaria gracilis* H. B. K. Nov. Gen. & Sp. Pl. **1**: 109 (1815). *Setaria imberbis* R. & S. of authors. (Fig. 4.)

A slender, erect, glabrous, cæspitose perennial, 3 to 7 dm. high, from short, creeping rootstocks, with linear-setaceous leaves, very slender, spike-like panicles 2 to 6 cm. in length, and short setæ, often barely exceeding the spikelets. Culms very slender, erect, glabrous, cylindrical, simple or somewhat branched at the base; nodes glabrous; sheaths loose, glabrous, shorter than the internodes, not ciliate on the hyaline margins; ligule very short, ciliate; leaf-blades involute-setaceous, 0.5 to 2 dm. long, 1 to 3 mm. wide, smooth or slightly scabrous above, long-acuminate. Panicles cylindrical, dense, 3 to 5 mm. in diameter, branches contiguous, very short, 1-flowered; rachis setose or pubescent; setæ 5 to 8, involucrate, unequal, very short, flexuous, equaling or twice exceeding the spikelet,- yellowish, antrorsely scabrous. Spikelets 2 mm. long, ovate, acute; first glume triangular-ovate, acute, 3-nerved, one-third the spikelet in length; second glume one-half as long as the spikelet, ovate, acute, 5-nerved; third glume equaling the flowering glume, 5-nerved, sulcate, subtending a broad-ovate, hyaline palea its own length; flowering glume ovate, acute, abruptly apiculate, transversely undulate-rugose. Palea plane, striate.

Alabama, Florida, Texas, Mexico to South America.

Specimens examined.—*Alabama:* Mobile, on "ballast" and about wharves, 14 Mohr 1891; 19 Kearney 1895. *Florida:* Apalachicola, on "ballast," Chapman, no date. *Texas:* No locality, Buckley 1888; Nealley 1887, 1888; Corpus Christi, Nealley 1891. *Cuba:* 3473 Wright 1860–64; Reed, no date. *Mexico:* Cordova, 5 Fink 1889–1891; Chihuahua, Palmer 1885; Oaxaca 1907, Nelson 1894.

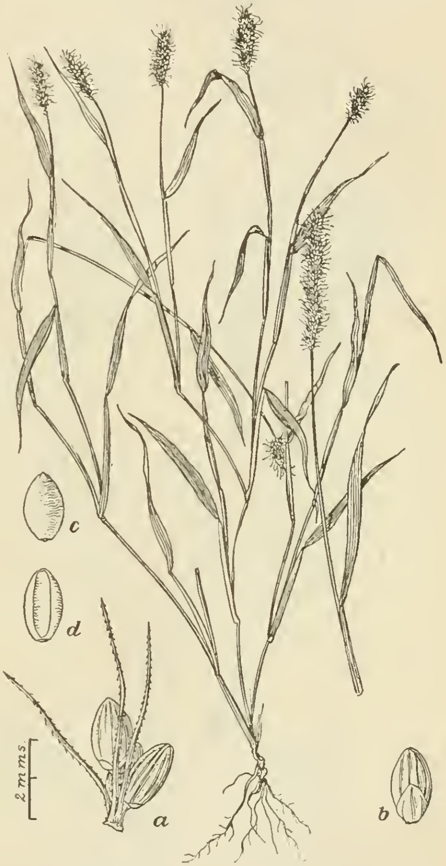

Fig. 5.—*Chætochloa brevispica: a,* branch showing spikelets and setæ; *b,* spikelet showing the first and third glumes; *c,* flowering glume seen from the back; *d,* anterior view of the flowering glume, showing palea.

B. *Setæ 1–3, not involucrate.*

**Panicle dense cylindrical; branches short, approximate.*

†*Setæ retrorsely scabrous, wholly or in part.*

5. **CHÆTOCHLOA BREVISPICA** nom. nov. *Panicum verticillatum parviflorum* Doell in Mart. Fl. Bras. 2^2: 172. (1877), not *Cenchrus parviflorus* Poir. in Lam. Encycl. **6**: 52 (1804.). (Fig. 5.)

A low, spreading, much-branched annual, 1 to 3 dm. high, with short, cylindrical spikes and lanceolate leaves 3 to 6 cm. long. Culms compressed, geniculate, decumbent, very glabrous; nodes smooth; sheaths very loose, striate, compressed, glabrous, margins smooth, shorter than their internodes; ligule short, densely ciliate-fringed with white hairs; leaf-blades 3 to 6 cm. long, 4 to 8 mm. wide, cordate at the base, long-acuminate at the apex, scabrous and sparingly papillate ciliate on both sides, especially below, margins cartilaginous, serrulate-scabrous. Inflorescence dense, cylindrical, 1 to 3 cm. long, about 1 cm. in diameter, purplish; common axis angular, scabrous; branches very short, subverticillate, densely flowered; setæ 1 or 2, purple, stout, flexuous, retrorserly scabous, 3 to 8 mm. long. Spikelets 1.5 to 2 mm. long, nearly sessile, elliptical-ovate; first glume triangular-ovate, acute or obtuse, 3-nerved, about one-third the length of the spikelet; second glume ovate, obtuse, 5 to 7-nerved, nearly equaling the 5 to 7-nerved, acute third glume, which bears a short palea in its axil; flowering glume about 1.5 mm. long, elliptical-ovate, acute, striate, nearly smooth or very finely transversely wrinkled below. Palea similar in texture and markings, about as long as the glume.

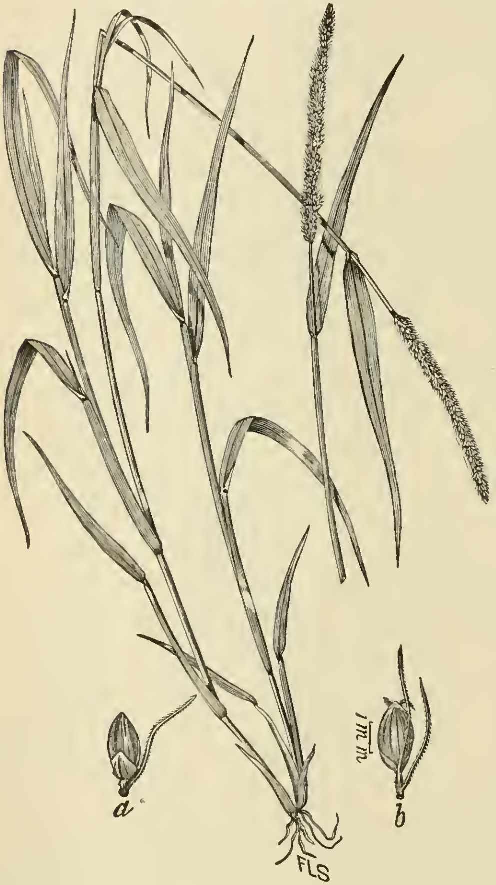

Fig. 6.—*Chætochloa verticillata:* *a*, *b*, views of the spikelet, showing the setæ.

Alabama, Louisiana, Mexico, South America, Europe.

Specimens examined.—*Louisiana:* Port Eads, Langlois 1885, on "ballast." *Alabama:* Mobile, on "ballast," Mohr 1888. *Mexico:* Guadalajara, 484 Palmer 1886.

Very readily distinguished from *C. verticillata* by its smaller size, more spreading habit, short cylindrical spikes, and smaller spikelets.

6. **Chætochloa verticillata** (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum verticillatum* L. Sp. Pl. ed. 2, 82 (1762). *Setaria verticillata* Beauv. Agrost. 51 (1812). *Chamæraphis verticillata* Porter Bul. Torr. Bot. Club. **20**: 196 (1893). *Ixophorus verticillatus* Nash Bul. Torr. Bot. Club. **22**: 422 (1895). (Fig. 6.)

An erect or ascending, glabrous, somewhat cæspitose annual, 3 to 6 dm. high, with linear-lanceolate leaves and interrupted subspiciform panicles 5 to 10 cm. long. Culms geniculate, glabrous, compressed; nodes brown or black, smooth; sheaths loose, shorter than their internodes, smooth, striate, margins glabrous below, ciliate above; ligule short, hispid-ciliate; leaf-blades flat, soft, 7 to 18 cm. long, 6 to 12 mm. wide, acuminate, abruptly narrowed at the rounded base, scabrous on both sides, serrulate-scabrous on the cartilaginous margins. Panicles spike-like; rachis striate, angular, scabro-hispid; branches subverticillate, short, densely flowered; setæ 1 to 3, stout, flexuous, retrorsely scabrous to the very base, 3 to 6 mm. long. Spikelets nearly sessile, narrowly elliptical-ovate, acute, 2 to 2.5 mm. long; first glume triangular-ovate, acute, 3-nerved, one-third as long as the spikelet; second glume elliptical-ovate, 5 to 7 nerved, mucronate, nearly equaling the 5 to 7 nerved acute third glume and slightly exceeding the flowering glume; third glume subtending a lanceolate, hyaline palea two-thirds its own length; flowering glume about 2 mm. long, narrowly elliptical, rounded at the apex and very shortly apiculate, smooth or with very fine transverse wrinkles below the middle. Palea similar in markings, equaling the glume.

A cosmopolitan weed widely distributed in the eastern United States. Introduced from Europe. July–October.

Specimens examined.—*Massachusetts:* Salem, Conant 1879. *Connecticut:* New Haven, Allen 1879. *Pennsylvania:* Philadelphia, Parker 1877; Stickers, Smith; Easton, Porter 1895. *Delaware:* Wilmington, 145 Commons 1897. *District of Columbia:* Vasey 1886. *Alabama:* Mobile, 14 Mohr 1891. *Kentucky:* Lexington, Short 1835. *Iowa:* Mt. Cyr, 929 Beard 1897; Mt. Pleasant, 773 Mills 1897. *Missouri:* St. Louis, 267 Eggert 1886. *Wisconsin:* Oshkosh, Random 1896.

7. **CHÆTOCHLOA SCANDENS** (Jacq.) n. comb. *Pennisetum scandens* Jacq. Hort. Vindb. (1801). *Setaria scandens* Schrad. in R. & S. Mant. **2**: 279 (1824). *Panicum scandens* Trin. Gram. Pan. 166 (1826).

An erect or ascending cæspitose annual, 4 to 7 dm. high, with geniculate, subcompressed culms, linear-lanceolate leaves, and loose, bristly subspiciform panicles 4 to 12 dm. long. Culms slender, branching at the base, scabrous below the panicle, otherwise glabrous; nodes brown or black, smooth; sheaths loose, striate, compressed, glabrous or slightly scabrous above, about equaling the internodes, margins ciliate above; ligule very short, bearded; leaf-blades linear to linear-lanceolate, spreading, plane, 5 to 16 cm. long, 2 to 5 mm. wide, long-acuminate, abruptly narrowed at the rounded base, scabrous and short strigose-pubescent on both sides, serrulate-scabrous on the cartilaginous margins. Panicle cylindrical, 1 to 1.5 cm. in diameter; rachis striate, densely short-pubescent or pilose; branches short, few-flowered, contiguous, spirally arranged; setæ 1 to 3, generally purplish, flexuous, 1 to 2 cm. long, retrorsely scabrous above, antrorsely scabrous at the base, spreading. Spikelets 1 to 1.5 mm. long, ovate, acute, green or purplish; first glume broadly ovate, acute, 3-nerved, one-half as long as the spikelet and inclosing its base; second and third glumes equaling the flowering glume, 5-nerved, acute, apiculate, the third somewhat sulcate; flowering glume ovate, acute, 1 to 1.5 mm. long, striate, transversely undulate-rugose below, nearly smooth above, the inclosed palea ovate, striate, concave.

West Indies, Central and South America.

Specimens examined.—*Puerto Rico:* 6498 Sintenis 1887, distributed as *Setaria verticillata* Beauv. *Honduras:* 5583 *bis* J. Donnell Smith 1888. *Guatemala:* Buena Vista, 4295 J. Donnell Smith 1892. *Venezuela:* 1144 Fendler 1854–55; 1644, 1856–57. *Brazil:* 4356, 4510 Burchell; 174 Riedl.

Readily distinguished from *C. verticillata* by its smaller spikelets, strigose-pubescent leaves, and longer, irregularly spreading setæ, which are retrorsely scabrous above and antrorsely scabrous at the base.

†† *Setæ antrorsely scabrous.*

‡ *Flowering glume smooth or nearly so.*

§ *Rachis scabrous.*

8. **CHÆTOCHLOA AMBIGUA** (Guss.) n. comb. *Setaria verticillata* var. *ambigua* Guss. Prodr. **1**: 80 (1827). *Setaria ambigua* Guss. Fl. Sic. Syn. **1**: 114 (1842). Not *Setaria ambigua* Schrad. Linnæa **12**: 430 (1838). (Fig. 7.)

A cæspitose, erect, much branched annual, 2 to 5 dm. high, with compressed culms, lanceolate leaves, and rather loose spicate panicles 4 to 10 cm. long. Culms geniculate at the base, glabrous, leafy, the nodes brown, glabrous; sheaths striate, compressed, loose, about equaling the internodes, thin, glabrous, the margin ciliate above; ligule about 1 mm. long, densely ciliate-fringed with white hairs, which are 1 mm. long or less. Leaf-blades lanceolate, cordate at the base, long-acuminate at the apex, 5 to 15 cm. long, 6 to 15 mm. wide, scabrous on both sides and on the cartilaginous margins. Axis of the inflorescence channeled, scabrous, but not pilose; branches short, subverticillate, densely flowered, the lower rather remote; setæ solitary, stout, somewhat flexuous, antrorsely scabrous, 4 to 8 mm. long. Spikelets elliptical, 2 to 2.5 mm. long; first glume triangular-cordate, 3-nerved, clasping the base of the spikelet and about one-third its length; second and third glumes equaling the flowering glume in length, obtuse, 5 to 7 nerved, the third with a palea; flowering glume 2 mm. long, elliptical, rounded at the apex, striate, very finely transversely wrinkled, not rugose. Palea similar in texture and markings.

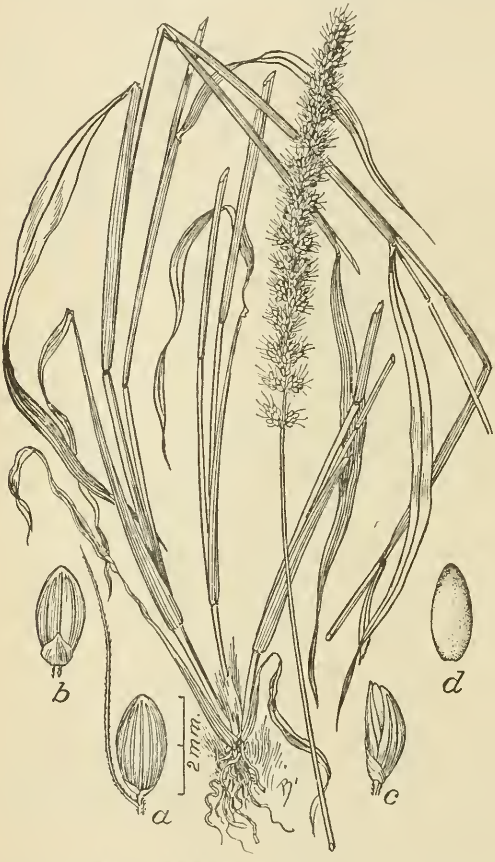

FIG. 7.—*Chætochloa ambigua*: *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

Collected on "ballast," Camden, N. J., by F. Lamson-Scribner, 1884, and at Mobile, Ala., by Chas. Mohr, 1884.

An adventitious European annual with the habit and inflorescence of *C. verticillata* (L.) Scribner, but readily distinguished from that species by its having the setæ antrorsely instead of retrorsely scabrous. Distinguished from *C. viridis* (L.) Scribner, by its loose, subverticillate panicles and scabrous, not pilose, rachis.

§ § *Rachis pilose.*

9. **Chætochloa viridis** (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum viride* L. Sp. Pl. ed. 2, 83 (1762). *Setaria viridis* Beauv. Agrost. 51 (1812). *Chamæraphis viridis* Porter Bul. Torr. Bot. Club. **20**: 196 (1893). *Ixophorus viridis* Nash Bul. Torr. Bot. Club. **22**: 423 (1895). (Fig. 8.)

An erect, glabrous, cæspitose annual, 2 to 9 dm. high, with short, lanceolate leaves and dense, cylindrical, spike-like green panicles 2 to 10 cm. long. Culms usually much branched at the base, glabrous, compressed; nodes smooth; sheaths compressed, loose, longer than the internodes, ciliate on the margins; ligule short, ciliate with long, white hairs; leaf-blades 0.5 to 2.5 dm. long, 4 to 10 mm. wide, scarcely narrowed at the cordate base, long-acuminate, slightly scabrous on both sides or sometimes nearly glabrous, serrulate-scabrous on the cartilaginous margins. Panicles linear-ovate in outline, tapering to the obtuse apex; rachis striate, villous, generally about 1 cm. in diameter, exclusive of the bristles; setæ slender, strict, spreading, antrorsely scabrous, 1 to 1.5 cm. long, green or rarely purplish. Spikelets about 2 mm. long, elliptical; first glume triangular-ovate, 3-nerved, about one-third the spikelet in length; second and third glumes elliptical, obtuse, 5-nerved, equaling the spikelet, the third glume subtending a lanceolate, hyaline palea one-third its own length; flowering glume elliptical, rounded at the apex, finely and faintly transversely wrinkled below, or only striate and pitted, the inclosed palea equaling it in length, similar in texture and markings.

In waste places and cultivated grounds throughout North America. Naturalized from Europe. July–September.

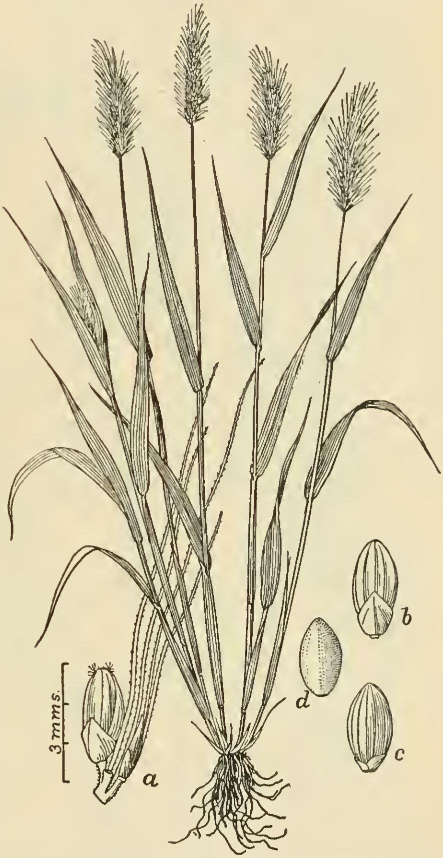

Fig. 8.—*Chætochloa viridis*: *a*, branch showing spikelet and setæ; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

Specimens examined.—*Newfoundland:* Waghorne 1892. *Ottawa:* Macoun 1894, Fletcher 1891. *Maine:* Auburn, Merrill 1897. *New Hampshire:* Peterboro, 236 Robinson 1897. *Connecticut:* 26 Wilson 1892. *New York:* Union Springs, 37 Dudley; Oxford, Coville 1884. *Pennsylvania:* Easton, Porter 1887; Harrisburg, Small 1888; Philadelphia, Smith. *Delaware:* Stanton, 147 Commons 1897. *District of Columbia:* Blanchard 1891, 532 Pollard 1895, Topping 1895. *Ohio:* Ricksecker 1894. *Michigan:* Clifton, 629 Farwell. *Tennessee:* Knoxville, Scribner. *Iowa:* Battle Creek, 956 Preston 1897; Fayette Co., 273 Fink 1894; Carnarvon, 291 Pammel 1896; Clinton, 268 Ball 1895; Des Moines, 28 Ball 1898; Manchester, 1007 Ball 1897. *Kansas:* Riley, 576 Norton 1895; Syracuse, 129 Thompson 1893; Hooker Co., 1568 Rydberg 1893; Wiegand, 2684 Clements 1893; Central City, 262 Shear 1895, 2009 Rydberg 1895; Kearney, Holmes 1889. *Wisconsin:* Oshkosh, Random 1896; Newbold, 1701 Cheney 1893. *South Dakota:* Aberdeen, 123 Griffiths 1896; Redfield, 208 Griffiths 1897. *Missouri:* St. Louis, 268 Eggert. *Colorado:* Thomas 1869, 510 Jones 1878; Colorado Springs, 2158 Williams 1896; Glenwood Springs, 1304 Shear & Bessey 1898. *Utah:* 6034 Jones 1894; Caineville, 5696*b* Jones 1894. *Oregon:* Milton, 33 Brown 1896. *North Carolina:* Magnetic City, 9 Wetherby 1895. *Alabama:* Tuskegee, 15 Carver 1897. *Mississippi:* Ocean Springs, 1 Forkert 1898. *Texas:* Kerrville, Nealley 1899, Heller 1894. *New Mexico:* Mesilla, 89 Wooton 1897. *Arizona:* Verde Valley, 532 McDougal 1891. *Mexico:* 349 Liebmann 1841–1843.

10. Chætochloa italica (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum italicum* L. Sp., Pl. 56 (1753). *Setaria italica* Beauv. Agrost. 51 (1812) *Chamæraphis italica* Kuntze Rev. Gen. Pl. **2**: 768 (1891). *Ixophorus italicus* Nash Bul. Torr. Bot. Club **22**: 423 (1895). (Fig. 9.)

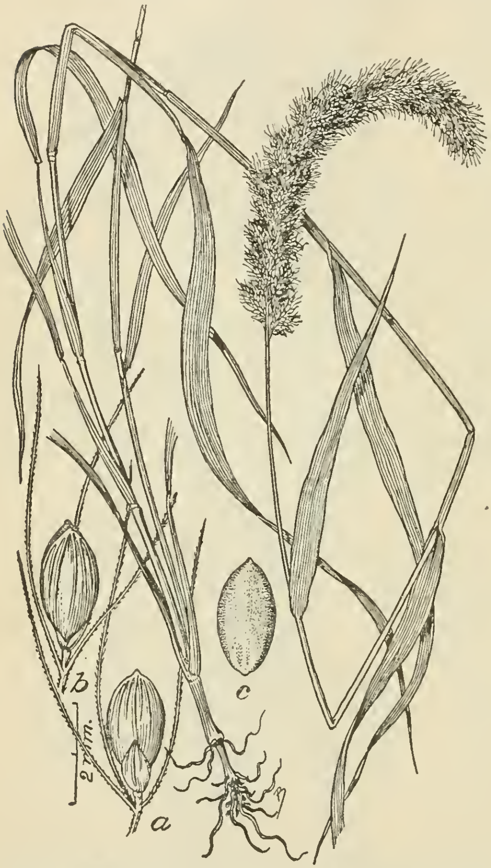

FIG. 9.—*Chætochloa italica: a, b,* views of the spikelets, showing the setæ; *c*, flowering glume, dorsal view.

A stout, erect, somewhat glaucous annual, with broad leaves and large, dense, compound, spiciform panicles 8 to 20 cm. in length. Culms simple or branching at the base, 3 to 8 mm. in diameter below, glabrous or slightly scabrous below the nodes and panicle; nodes bearded with short appressed hairs; sheaths loose, striate, glabrous or somewhat scabrous, subcompressed, generally exceeding the internodes, ciliate on the margins; ligule short, densely ciliate-fringed with white hairs 2 to 3 mm. long; leaf-blades lanceolate, narrowed at the base, long-acuminate, 2 to 4 dm. long, 1.5 to 3 cm. wide, scabrous on both sides, serrulate-scabrous on the cartilaginous margins. Panicles dense, cylindrical, green, becoming yellow at maturity, 2 to 3 cm. in diameter, obtuse or truncate at both ends, sometimes interrupted below; rachis densely villous, branches 1 to 2 cm. long, contiguous, densely flowered; setæ 1 to 3, green or purplish, 3 to 10 mm. long, often shorter than the spikelets or nearly obsolete, antrorsely scabrous. Spikelets elliptical, strongly convex, 2.5 to 3 mm. long, obtuse; first glume one-fourth to one-half as long as the spikelet, acute, 1 to 3 nerved; second and third glumes about equaling the flowering glume, 5 to

7 nerved; flowering glume glossy, nearly smooth or finely and faintly transverse-rugose or pitted, striate; the inclosed palea similar in markings, slightly convex. Widely cultivated and often an escape in fields and waste places; very variable. Quebec to Minnesota, south to Florida and Texas. Native of Europe and Asia. July–September.

Chætochloa italica germanica (Mill.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **6**: 32 (1897). *Panicum germanicum* Mill. Gard. Dict., ed. 8, 1 (1768). *Setaria germanica* Beauv. Agrost. 51 (1812).

A smaller form, 2 to 6 dm. high, with slender culms, usually branching at the base; leaves 0.5 to 2 dm. long, 5 to 10 mm. wide, scabrous. Panicles dense, cylindrical, obtuse at the apex, usually tapering at the base, green or purplish, 5 to 10 cm. long, about 1 cm. in diameter; setæ purple, rarely green, 5 to 15 mm. long, much exceeding the spikelets. Flowering glume green or purplish, when green, usually more or less blotched with purple.

Like *C. italica*, this variety is widely cultivated in this country under the name of Hungarian grass or millet, with about the same range as the type; often escaped from cultivation in fields and waste places. Some forms of this grass can scarcely be distinguished from *C. viridis* (L.) Scribn., and it is probably only a form of that species changed by cultivation and intermediate between *C. viridis* and *C. italica*.

11. **Chætochloa magna** (Griseb.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Setaria magna* Griseb. Fl. Brit. W. Ind. 554 (1864). *Chamæraphis magna* Beal. Grasses of N. Am. **2**: 152 (1896). (Fig. 10.)

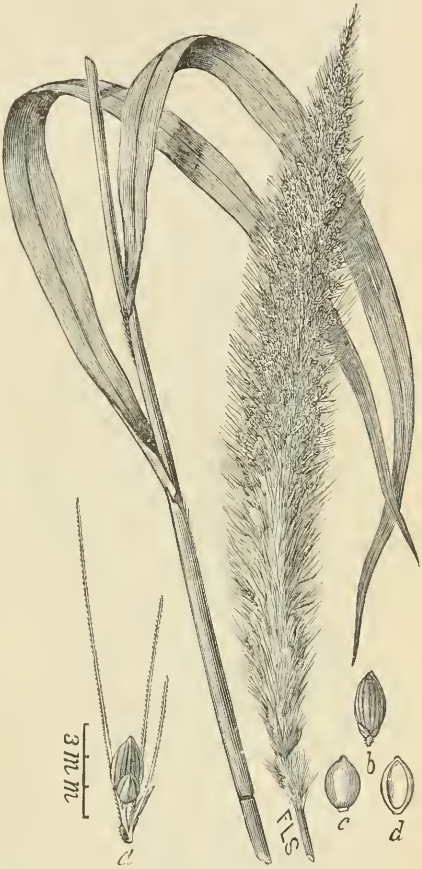

FIG. 10.—*Chætochloa magna: a*, branch showing spikelet and setæ; *b*, view of the spikelet; *c*, flowering glume; *d*, anterior view of the flowering glume, showing palea.

A coarse, stout, erect perennial (?) 10 to 36 dm. high, with cylindrical culms 0.5 to 2 cm. thick at the base, linear-lanceolate leaves and dense, cylindrical panicles 1.5 to 3 dm. long. Culms branching at the base, glabrous or slightly scabrous below the smooth nodes; sheaths loose, spreading, striate, compressed, glabrous, scabrous on the keel, margins smooth and hyaline below, densely ciliate-fringed above; ligule very short, ciliate-fringed with white hairs; leaf-blades 3 to 6 dm. long, 1 to 3 cm. wide, long attenuate-pointed, gradually narrowed to the base, scabrous on both sides, serrulate-scabrous on the cartilaginous margins. Panicles green, virgate, generally interrupted below, 2 to 5 cm. in diameter; rachis striate, densely pilose, branches 1 to 5 cm. long, strict, densely flowered, contiguous, much exceeding their internodes, or the lower rather remote; setæ 1 to 3, green, slender, antrorsely scabrous, 8 to 11 mm. long. Spikelets elliptical, acute, 2 mm. long; first glume broadly ovate, acute or obtuse, 3 to 5-nerved, inclosing the base of the spikelet; second glume equaling the spikelet, short-apiculate, 5 to 9-nerved; third glume 5-nerved, slightly sulcate, subtending an ovate, hyaline palea nearly its own length; flowering glumes elliptical-ovate, acute, short-apiculate, nearly 2 mm. long, very smooth, glossy, not striate or rugose, the inclosed palea equaling the glume, very smooth.

Low grounds and marshes, often in shallow water, Delaware to Florida, Louisiana, and western Texas, Bermuda, West Indies, Central America.

Specimens examined.—*Delaware:* Collins Beach, 148 Commons 1892; Woodland Beach, 148*a* Commons 1892; *District of Columbia:* Cultivated, Vasey 1889; *Virginia:* Smiths Island, Palmer 1897; *Florida:* Curtiss 1885; Merrits Island, Indian River, 3618 Curtiss 1879; Apopka, 21 Baker 1897; Fort Ogden, Lowe 1892; Deland Co., Hill 1899; Grasmere, 1054 Combs & Baker, 1898; Barstow, 1219 Combs 1898; Homosassa, 464 Combs 1898; Eustis 1279 Nash 1894; *Louisiana:* Pointe-à-la-Hache, 56 Langlois 1879; *Texas:* 801 Wright 1849; *Bermuda:* Munro 1864; *Costa Rica:* 6825 Pittier 1892.

‡‡ *Flowering glume transversely undulate-rugose.*

† *Rachis very densely pilose.*

12. **CHÆTOCHLOA LONGIPILA** (Fourn.) n. comb. *Setaria longipila* Fourn. Mex. Pl. Enum. Gram. 47 (1886).

An erect, somewhat cæspitose, glabrous annual, 3 to 5 dm. high, with slender culms, short, lanceolate leaves and somewhat exserted, green, subspiciform panicles 2 to 7 cm. in length. Culms glabrous, except below the panicle, branching at the base; nodes brown, bearded with appressed hairs; sheaths slightly compressed, striate, glabrous, much shorter than the internodes, ciliate on the margins, slightly bearded at the apex; ligule short, ciliate-fringed with long white hairs; leaf-blades 5 to 10 cm. long, 5 to 10 mm. wide, tapering to the base and to the acute or acuminate apex, scabrous on the upper side and on the cartilaginous margins, nearly smooth beneath. Panicles about 6 mm. in diameter, interrupted, the branches short, few-flowered; rachis densely pilose-pubescent, with long, erect, white hairs extending a short distance below the panicle; setæ 1 to 3, green, stout, antrorsely scabrous, flexuous, 3 to 5 mm. long. Spikelets ovate-globose, acute, about 1.7 mm. long; first glume about one-half as long as the spikelet, triangular-ovate, acute, 3-nerved, slightly inclosing the base of the spikelet; second glume equaling the flowering glume, strongly convex, 5-nerved; third glume slightly exceeding the flowering glume and somewhat inclosing it, 5-nerved, apiculate, subtending a broadly-ovate, hyaline palea of nearly its own length; nerves in all the glumes green, prominent; flowering glume strongly convex, broadly ovate, acute, strongly transversely undulate-rugose, the inclosed palea striate, strongly convex at the base, concave above, equaling the glume in length.

Mexico. August.

Specimens examined.—2017 Rose 1897, foothills of the Sierra Madre Mountains, Territorio de Tepic, between Agnacato and Dolores.

This species has much the same habit as *C. liebmanni pauciflora*, but is at once disguished from that and other related forms by its small, ovate, globose spikelets and remarkably dense pilose-pubescent rachis.

†† *Rachis thinly pilose.*

= *Leaves scabrous.*

13. **Chætochloa corrugata** (Ell.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum corrugatum* Ell. Sk. Bot. S. Car. & Ga. **1**: 113 (1817). *Setaria*

corrugata R. & S. Mant. **2**: 276 (1824). *Chamæraphis corrugata* Kuntze Rev. Gen. Pl. **2**: 770 (1891). (Fig. 11.)

A rather stout, erect or ascending cæspitose annual, 6 to 10 dm. high, with elongated, spike-like panicles and linear-lanceolate, scabrous leaves. Culms compressed, striate, scabrous below the nodes and panicle, otherwise smooth, much branched at the base, often geniculate and rooting at the lower nodes; nodes brown, bearded with short appressed hairs; sheaths very loose, compressed, keeled, the lower ones usually much exceeding the internodes, scabrous or sometimes nearly smooth, rarely pubescent, smooth or ciliate on the margin; ligule fringed with rather rigid white hairs; leaf-blades 1 to 3 dm. long, 3 to 6 mm. wide, scabrous on both sides, serrulate-scabrous on the cartilaginous margins, tapering to the base, acuminate-pointed. Panicles cylindrical, dense, narrowed to the obtuse apex, 6 to 16 cm. long, 6 to 15 mm. in diameter below, exclusive of the setæ; rachis angular, pilose; branches short, contiguous, densely 5 to 15 flowered; setæ 1 or rarely 2 at each spikelet, green or purplish, erect-spreading, flexuous, 5 to 15 mm. long, antrorsely scabrous. Spikelets ovate, acute, about 2 mm. long, gibbous; first glume one-third to one-half as long as the spikelet, ovate-cordate, acute, 3 to 5 nerved, inclosing the base of the spikelet; second glume broadly ovate, acute or obtuse, apiculate, about four-fifths as long as the spikelet, 5 to 7 nerved, the mid-nerve excurrent, the lateral ones anastomosing or abruptly vanishing in the hyaline margin; third glume equaling and slightly inclosing the flowering glume, sulcate, 5-nerved, subtending a lanceolate, hyaline palea, nerves in all the glumes green, prominent; flowering glume ovate, acute, convex, very strongly transversely undulate-rugose for its whole length; the inclosed palea transversely striate, slightly convex at the base, plane above.

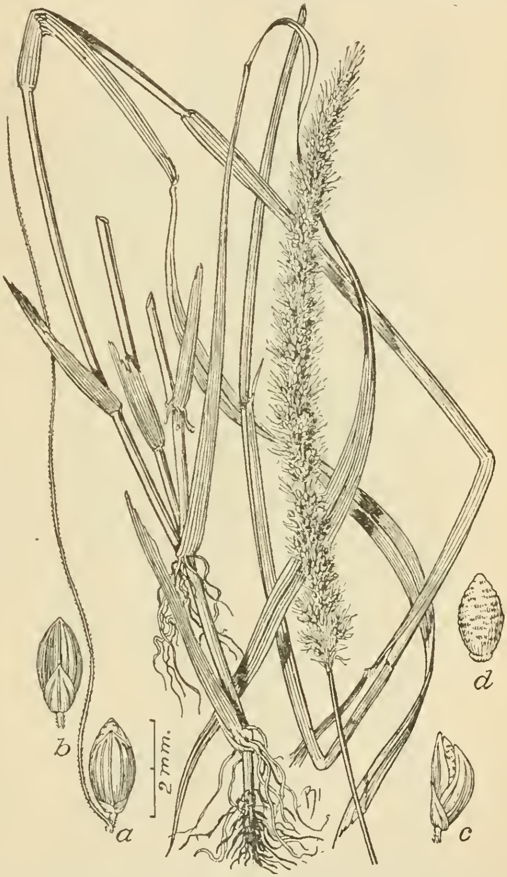

FIG. 11.—*Chætochloa corrugata:* *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

In waste places, cultivated fields, etc., Georgia to Florida. July–October.

SPECIMENS EXAMINED.—*Florida:* Jacksonville, 3616 Curtiss; no locality, Chapman, Duval Co., 328 Fredholm 1893; Apalachicola, 108 Kearney 1895; Anastasia Island, 175 Kearney 1895; Grasmere, 1047 Combs & Rolfs 1898; Cedar Key, 795 Combs 1898; Orange, Baker 1897; Homosassa, 944 Combs 1898.

CHÆTOCHLOA CORRUGATA PARVIFLORA (Poir.) n. comb. *Cenchrus parviflorus* Poir. in Lam. Encycl. **6**: 52 (1804). *Setaria ventenatii* Kunth Rev. Gram. **1**: 251. t. 37 (1829). *Panicum glaucum purpurascens* Ell. Sk. Bot. S. Car. & Ga. **1**: 113 (1817). (Fig. 12.)

A more slender form 2 to 7 dm. high, much branched from the base, leaves shorter, panicles exserted, 2 to 7 cm. long, branches few-flowered, setæ spreading, green or purple; spikelets as in the type.

In fields and waste places, South Carolina to Florida, West Indies. April–October.

Specimens examined.—Specimen in Herb. Phil. Acad. Sci., collected by Elliot, South Carolina or Georgia. *Florida:* Indian River, Curtiss 1879; Jacksonville, 5124 Curtiss 1894; 4041 Curtiss 1893; without locality, Curtiss 1885; Vesterand 1889; Duval Co., 187 Frédholm 1893, Eustis 640, 1382 Nash 1894; Lake City, 140 Combs & Rolfs 1898; Gainesville, 721, 723 Combs 1898; Homosassa, 945 Combs 1898; Barstow, 1177 Combs 1898; Old Town, 865 Combs 1898; Dunnellon, 914*a* Combs 1898; Manatee Co., 1287, 1292 Combs 1898; Miami, 253 Pollard 1898.

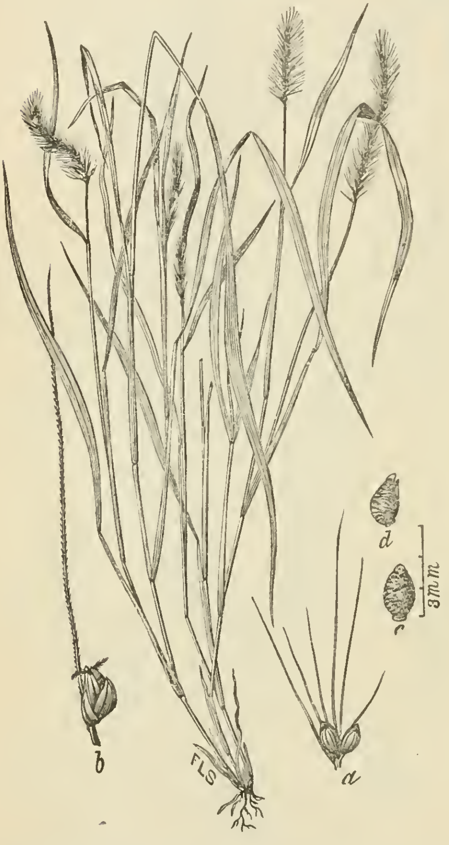

Fig. 12.—*Chætochloa corrugata parviflora: a*, branch showing two spikelets and setæ; *b*, spikelet; *c*, *d*, views of the flowering glume.

== *Leaves pilose or pubescent.*

14. **CHÆTOCHLOA GIBBOSA** sp. nov.

An erect, densely cæspitose, pubescent perennial, 4 to 7 dm. high, with rather loose, cylindrical, exserted panicles, compressed sheaths, and linear-lanceolate leaves, which are strongly pilose on both sides with long spreading white hairs. Culms slender, smooth, cylindrical; nodes brown or black, smooth; sheaths loose, striate, smooth, the margin densely ciliate with long erect white hairs, bearded at the apex; ligule brown, about 1 mm. long, densely ciliate-fringed with white hairs 3 or 4 mm. long; leaf-blades 1 to 2.5 dm. long, 5 to 7 mm. wide, abruptly rounded at the base, long-acuminate, scabrous on both sides and on the cartilaginous margins. Panicle 5 to 7 cm. long, loose, branches very short, few-flowered; setæ 1 or 2 at each spikelet, spreading-erect, flexuous, 8 to 15 mm. long, antrorsely scabrous. Spikelets ovate-globose, 2 mm. long, acute; first glume nearly one-half as long as the spikelet, broadly ovate-cordate, obtuse, apiculate, 5-nerved, inclosing the base of the spikelet; second glume broadly ovate, obtuse, abruptly apiculate, 5 to 7 nerved, about four-fifths as long as the spikelet; third glume equaling and slightly inclosing the flowering glume, 5-nerved, plane, subtending a lanceolate, hyaline palea; flowering glume strongly gibbous, acute, short-apiculate, transversely undulate-rugose, except at the nearly smooth base and apex, the inclosed palea broadly elliptical-ovate, very strongly convex, transversely striate.

Type specimen in Gray Herbarium Cambridge, No. 528 (828?), "Herbarium Berlandierianum Texano-Mexicanum," no locality or date.

A very distinct species, readily recognized by its broad-linear, pilose leaves, densely bearded sheath-margins and ligule, long first glume, and strongly convex palea.

15. **CHÆTOCHLOA HISPIDA** sp. nov. (Fig. 13.)

A simple or sparingly branched, erect, somewhat hirsute annual, about 6 dm. high, with linear-lanceolate leaves and exserted, cylindrical, spike-like panicles about 6 cm. long. Culm slender, compressed below, somewhat geniculate, striate, scabrous below the panicle, thinly pilose for its whole length with scattered white hairs; nodes bearded with appressed hairs; sheaths compressed, striate, strigose with rather long white hairs, especially above and on the margins; ligule short, ciliate; leaf-blades 10 to 15 cm. long, 4 to 6 mm. wide, tapering to the base, acuminate, scabrous on both sides and margins, papillate-pilose on the nerves on both sides, mid-nerve very prominent on the lower side, smooth. Panicle densely flowered, about 7 mm. in diameter exclusive of the setæ; rachis angular, pilose; branches short, contiguous, 1 to 3 flowered; setæ 1 or 2, green, spreading, 8 to 12 mm. long, antrorsely scabrous above, nearly smooth at the base; first glume nearly one-half as long as the spikelet, broadly ovate-cordate, acute, apiculate, 3-nerved, inclosing the base of the spikelet; second glume broadly-ovate, obtuse, about four-fifths as long as the spikelet, short-apiculate, 7-nerved, the mid-nerve excurrent, the lateral ones vanishing; third glume equaling the flowering glume, sulcate, 5-nerved, subtending a lanceolate, hyaline palea; flowering glume elliptical-ovate, acute, strongly gibbous, transversely undulate-rugose, the inclosed palea convex at the base, plane above.

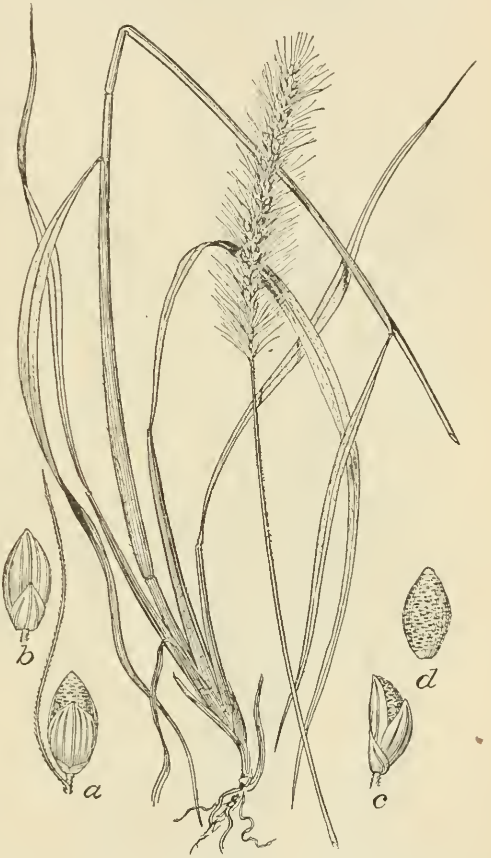

FIG. 13.—*Chætochloa hispida: a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

In sandy pine woods, Cuba. Type specimen in the Gray Herbarium, Cambridge, collected by C. Wright in January, 1865; no number.

Related to *C. corrugata* (Ell.) Scribn., but readily distinguished by its more simple habit, hirsute sheaths, pubescent leaves, and strongly rugose flowering glumes. This specimen is cited by Grisebach, Plant. Cub. 234 (1866), under *Setaria glauca imberbis.*

16. **CHÆTOCHLOA LEUCOPILA** sp. nov. (Fig. 14.)

A densely cæspitose, erect perennial, 2.5 to 4 dm. high, with narrow, involute leaves and rather loose, narrow panicles 3 to 6 cm. in length. Culms very slender, much branched at base, striate, scabrous or scabro-pubescent below the nodes and panicle, otherwise smooth; nodes brown, the lower ones densely bearded with long white hairs, the hairs on upper nodes shorter, sheaths loose, compressed, glabrous or usually slightly scabrous on the keel, margins nearly smooth below, densely ciliate-fringed with long white hairs above; ligule brown, very short, densely ciliate with spreading white hairs 3 to 5 mm. long; basal leaves numerous, those of the culms 1 or 2, linear, 5 to 10 cm. long, 2 to 4 mm. wide, rather soft, becoming involute-setaceous, densely bearded at the throat with spreading white hairs, which equal or exceed those of the ligule, the upper surface pilose with long white hairs, the lower surface smooth or only slightly scabrous. Panicle somewhat exserted, about 6 mm. in diameter, pale, few-flowered; axis undulate, angular, scabro-pubescent, branches 2 mm. long or less; setæ single or in pairs, green, flexuous, antrorsely scabrous, 2 to 5 mm. long. Spikelets oblong-ovate, acute, 3-nerved, barely 2 mm. long; first glume triangular-ovate, acute, 3-nerved, one-third as long as the spikelet; second glume broadly ovate, obtuse, apiculate, 5-nerved, two-thirds to three-fourths as long as the flowering glume; third glume equaling the flowering glume, 5-nerved, subtending a hyaline, lanceolate palea two-thirds its own length; flowering glume narrowly ovate, acute, apiculate, nearly smooth, striate and pitted below, not rugose, nearly smooth, shining at the apex, the inclosed palea broadly lanceolate, pitted, slightly convex for its whole length.

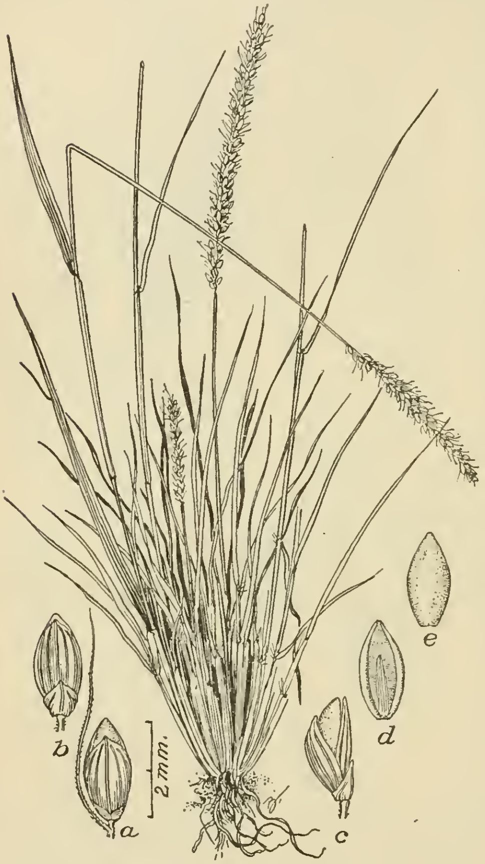

FIG. 14.—*Chætochloa leucopila.* *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, anterior view of the flowering glume, showing the sterile and fertile palea; *e*, flowering glume, dorsal view.

Mexico. Type specimen collected at Parras, State of Coahuila, Mexico, 1363 E. Palmer, June, 1880.

At once distinguished by its densely cæspitose habit, narrow leaves, densely bearded ligule, and pilose sheath margin, and leaves.

*** Panicle loose, interrupted; branches more or less elongated.*

† Branches densely flowered.

‡ Setæ both antrorsely and retrorsely scabrous.

17. **CHÆTOCHLOA ONURUS** (Griseb.) n. comb. *Setaria onurus* Griseb. Fl. Brit. W. Ind. 555 (1864). *Panicum onurum* Willd. in Herb., ex Griseb.

A stout, erect, glabrous perennial, 2 to 10 dm. high, with virgate, interrupted panicles and linear-lanceolate leaves, 1.5 to 4 dm. long. Culms glabrous, erect, simple or sparingly branched at the base, cylindrical; nodes glabrous; sheaths compressed, strigose-pubescent, sometimes slightly scabrous on the keel, the lower ones much longer than the internodes, imbricate, ciliate on the margins, bearded at the apex; ligule short, ciliate; leaf-blades 10 to 15 mm. wide, scabrous on both sides and on the cartilaginous margins, long-acuminate at the apex, tapering at the base, midvein prominent throughout. Panicle loose, cylindrical, 1 to 2 dm. long, 1.5 to 2 cm. in diameter; rachis striate, pilose; branches spreading-erect, the lower 1.5 to 2 cm. in length, scabrous, equaling or exceeding their internodes; setæ mostly solitary, rarely 2 or 3 at each spikelet, slender, flexuous, 1.5 to 2 cm. long, both antrorsely and retrorsely scabrous. Spikelets ovate-globose, acute, 2 mm. long; first glume one-third as long as the spikelet, triangular-cordate, acute, abruptly apiculate, 5-nerved; second glume one-half to two-thirds as long as the spikelet, broadly ovate, obtuse or truncate, apiculate, 9 to 11 nerved; third glume equaling the flowering glume, thin, 9-nerved, subtending an ovate hyaline palea nearly its own length; flowering glume ovate-globose, acute, generally abruptly apiculate, transversely undulate-striate below, smooth near the apex. Palea similar in markings, strongly convex.

West Indies, Mexico, South America.

Specimens examined.—*Jamaica:* March, spikelets from specimens cited by Grisebach (Fl. Brit. W. Ind. 555) sent from Kew Herbarium, also specimen in the Gray Herbarium. *Cuba:* 3474 Wright 1860, 1864, 3887 Wright 1865; Cienguita, 264 Combs 1895.

In habit very much resembling *C. macrostachya*, but readily distinguished from this and other related forms by its 9 to 11 nerved second glume and both antrorsely and retrorsely scabrous setæ.

‡‡ Setæ antrorsely scabrous only.

§ Leaves linear, glaucous.

18. **Chætochloa composita** (H. B. K.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Setaria composita* H. B. K. Nov. Gen. & Sp. Pl. **1**: 111 (1815). (Fig. 15.)

A pale, glaucous, cæspitose perennial, 3 to 10 dm. high, much branched from the base, with long, linear leaves and cylindrical, dense, or more or less interrupted spike-like panicles 5 to 16 cm. long, 6 to 15 mm. in diameter, exclusive of the setæ. Culms geniculate at the base, subcompressed, scabrous and often pubescent, especially below the nodes, rarely glabrous, the innovations usually short and sterile; nodes bearded with a ring of silky, appressed hairs; sheaths striate, compressed, slightly scabrous on the keel above, and pilose at the apex, otherwise glabrous, the lower sometimes pubescent, mostly shorter than the internodes, ciliate on the margins; ligule very short, densely ciliate-fringed with silky hairs 1.5 to 3 mm. long; leaf-blades linear, plane, 1 to 2.5 dm. long, 2 to 5 mm. wide, glaucous, long, narrow, acuminate at the apex, scabrous on both sides or sometimes nearly glabrous, midvein prominent below, obscure above. Panicle pale green; rachis angular, striate, pilose; branches short, densely flowered, contiguous, crowded or sometimes rather remote, especially below; setæ single, rarely in pairs, green, flexuous, 5 to 15 mm. long, antrorsely scabrous.

Spikelets short-pedicellate, narrowly ovate, acute, 2 or rarely 3 mm. long; first glume acute or acuminate, 3-nerved, one-half as long as the spikelet; second glume broadly ovate, acute or apiculate, 5-nerved, nearly equaling the spikelet in length; third glume similar to the second, 5-nerved, equaling the flowering glume, subtending a lanceolate, hyaline palea; glumes pale, with prominent green nerves; flowering glume narrowly ovate, acute, short-apiculate, striate, nearly smooth, obscurely transversely wrinkled below, the inclosed palea similar in texture and markings, convex.

Colorado to Arizona, Texas, Mexico, and South America. June–October.

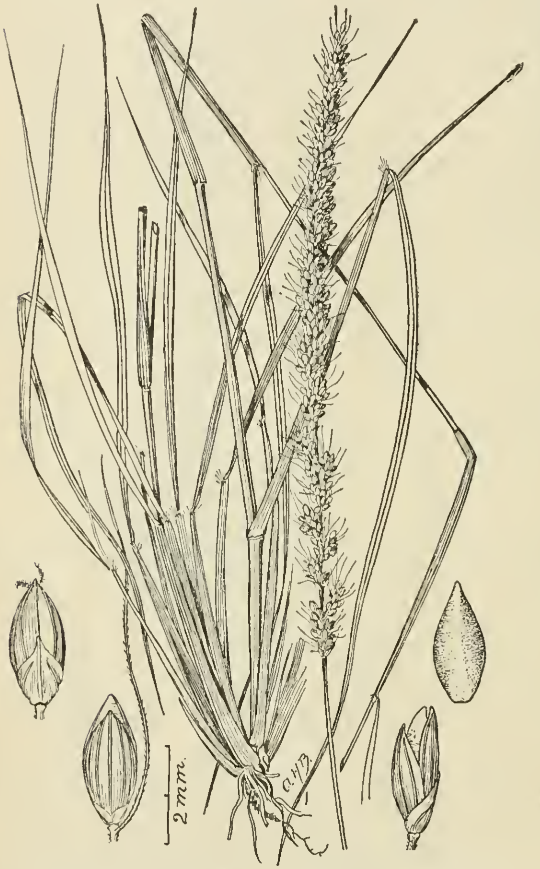

FIG. 15.—*Chætochloa composita*: spikelet showing seta, two views of the spikelet, and dorsal view of the flowering glume.

SPECIMENS EXAMINED.—*Colorado:* Canyon City, 780 Jones 1878, 4 Eastwood 1892, 979 Shear 1896. *Arizona:* No locality, Palmer 1869, Vasey 1889, 19, 21 Emersley 1890; Bisbee, 858, 926 Mearns 1892; Tucson, Pringle 1884, 805 Toumey 1892, 77 Toumey 1894; Gila Valley, 334 Rothrock 1874; Fort Verde, 939 McDougal 1891; Fort Huachuca, Wilcox 1894. *New Mexico:* No locality, 2094 Wright 1851–52; Mesilla, 60 Wooton 1897; Rincon, 41, 44*a*, 63 Jones 1884; Albuquerque, 85 Tracy 1887; Las Cruces, Vasey 1881; Mangos, Metcalfe 1897, Smith 1896. *Texas:* No locality, Nealley 1877; Western Texas, 799 Wright 1849; Maranillas, Havard 1883; Mesquite Bay, Ravenel 1869; Pinto Creek, Kinney Co., 83 Hall 1895; San Diego, Smith 1897; Painted Cave, Val Verde Co., 115 (in part) Nealley 1892. *Mexico:* Guaymas, 340 Palmer 1887; San Bernardino ranch, Mexican boundary, 746, 771, 781 Mearns 1892; San Luis Mountains, 2101 Mearns 1893; White Water, 2313 Mearns 1893.

This common southwestern grass has been variously referred by American authors and collectors to *Setaria caudata* and *Setaria setosa*, but is at once distinguished from these species by its pale aspect, cylindrical panicle, long glaucous leaves, and long first and third glumes. *Setaria caudata* in Bul. No. 12, Div. Bot. U. S. Dept. Agr., "Grasses of the Southwest," pl. 5 (1891), and in "Bot. of Western Texas," Contr. U. S. Nat. Herb. **2**: 510 (1894), *Chamæraphis caudata* in Beal Grasses of N. Am. **2**:157 (1896).

§§ *Leaves linear-lanceolate, green.*

19. **CHÆTOCHLOA MACROSTACHYA**[1] (H. B. K.) n. comb. *Setaria macrostachya* H. B. K. Nov. Gen. & Sp. Pl. **1**: 110 (1815). (Fig. 16.)

An erect or ascending perennial, 6 to 12 dm. high, with rather dense cylindrical panicles and linear-lanceolate leaves 1.5 to 5 dm. in length. Culms rather stout, compressed and more or less branched below, striate, scabrous below the nodês and panicle, otherwise smooth; nodes glabrous, sheaths loose, striate, glabrous, usually exceeding the internodes, scabrous on the keel, bearded at the apex, margins ciliate-fringed; ligule fringed with straight white hairs, 3 to 4 mm. long; leaf-blades rigid, linear-lanceolate, scarcely narrowed at the base, gradually tapering to the long acuminate apex, 1 to 1.5 cm. wide, scabrous on both sides or rarely nearly smooth, generally with a few long white hairs toward the base, midvein prominent throughout. Panicle pale green, strict, thyrsoid, cylindrical, usually tapering to the apex, 1 to 3 dm. long, 1 to 2 cm. in diameter; common axis angular, sparingly villous; branches short, contiguous, densely flowered, erect, exceeding their internodes, the lower generally slightly remote; setæ solitary or in pairs, slender, flexuous, antrorsely scabrous, 1 to 2 cm. in length. Spikelets ovate-globose, about 2 mm. long, acute; first glume one-third to one-half as long as the spikelet, broadly ovate, acute, inflated, and inclosing the base of the spikelet, 3 to 5 nerved; second glume two-thirds to three-fourths as long as the spikelet, broadly ovate, obtuse, apiculate, 5 to 7 nerved; third glume equaling the spikelet, slightly inclosing it by its infolded margins, sulcate, 5-nerved, subtending a lanceolate, hyaline palea about its own length; flowering glume strongly convex, apiculate, striate, and rather prominently transversely undulate-rugose, especially below, the inclosed palea equaling it in length, striate, nearly plane.

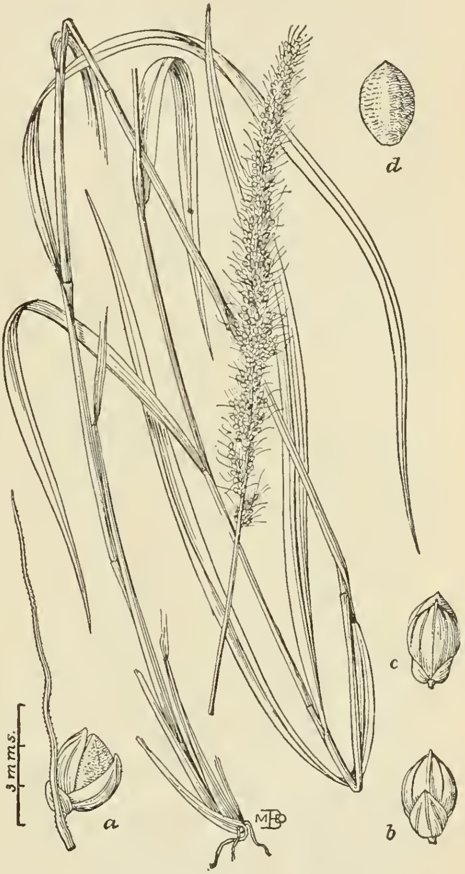

FIG. 16.—*Chætochloa macrostachya: a*, spikelet showing the seta; *b, c*, views of the spikelet; *d*, flowering glume, dorsal view.

Texas to Mexico and South America.

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[1] CHÆTOCHLOA AUSTRALIENSIS sp. nov.

A stout, erect, or ascending grass, with lanceolate leaves and rather dense panicles 1.5 to 2 dm. long. Culms glabrous, except below the nodes and panicles; ligule

Specimens examined.—*Texas:* Laredo, Havard 1884; no locality, Nealley 1887, 1888. *Mexico:* Mirado, 362 Liebmann 1841, cited by Fourn. Mex. Pl. Enum. Gram. 45; Guaymas, 53 E. Palmer 1887; no locality, 378, 505, and 872 E. Palmer.

A distinct species, readily distinguished from *C. composita* (H. B. K.) Scribn. by its gibbous spikelets and broader, lanceolate leaves; and from other related species by its dense subcylindrical panicles.

20. **CHÆTOCHLOA RIGIDA** sp. nov.

An erect, rigid perennial, 3 to 6 dm. high, with loose, narrow, interrupted panicles, few short setæ, and rigid, lanceolate leaves 1 to 2.5 dm. long. Culms cylindrical, somewhat branching below, striate, smooth, scabro-pubescent below the panicles and sometimes below the glabrous nodes; sheaths mostly close, equaling or exceeding the nodes, glabrous, the lower ones imbricate and scarcely striate, margins very smooth, not ciliate; ligule very short, sparingly ciliate, not exceeding 1 mm. in length; leaf-blades rigid, 6 to 12 mm. wide, minutely scabrous on both sides or nearly smooth, often minutely pubescent at the throat, serrulate-scabrous on the margins, narrowed at the base, acuminate, sometimes somewhat involute-setaceous above, midnerve very prominent on the lower side of the leaf for two-thirds its length, glabrous. Panicle 0.5 to 2 dm. long, strict, often scarcely exserted from the upper sheath, pale or straw-colored; rachis angular, short pubescent or somewhat villous, undulate; branches very short or nearly obsolete, the lower not exceeding 1 cm., erect; setæ solitary, often nearly obsolete, stout, flexuous, 3 to 10 mm. long. Spikelets 2 to 2.5 mm. long, ovate, acute; first glume about one-half as long as the spikelet, acute, 3-nerved, the midnerve excurrent, the lateral ones anastomosing with it; second glume one-half to two-thirds as long as the spikelet, 5 to 7 nerved, broadly ovate, acute, apiculate; third glume equaling the flowering glume and slightly inclosing it with its infolded margins, 5-nerved, sulcate, subtending a lanceolate, hyaline palea two-thirds its own length; flowering glume ovate, acute, apiculate, obscurely keeled, striate, transversely undulate-rugose below, nearly smooth and glossy at the apex, the inclosed palea similar in markings and texture, nearly plane.

Lower California. September–February.

Specimens examined.—*Lower California:* La Paz, 125 E. Palmer 1890 (type); Carmen Island, 857 Palmer 1890; San José del Cabo, 28 Brandegee 1890.

All these plants were distributed under the names of *Setaria caudata* and *S. setosa*, from both of which this species is very distinct. Readily distinguished by its rigid culms, smooth sheaths, narrow, straw-colored panicles, and few, usually very short, setæ. Related to *C. macrostachya.*

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densely bearded with stiff hairs; leaves 2 to 3 dm. long, 1.5 to 2 cm. wide; nodes smooth. Panicle about 2 cm. in diameter; rachis scabrous, sparingly villous; setæ solitary, erect-spreading, 1 to 1.5 cm. long. Spikelets 3 mm. long, narrowly ovate, acute; first glume one-third to one-half as long as the spikelet, acute, 3 to 5-nerved; second glume four-fifths as long as the spikelet, acute, apiculate, 7-nerved, nerves prominent; third glume equaling the spikelet, 5-nerved, subtending a broad-lanceolate, hyaline palea its own length; flowering glume acute, apiculate, strongly transversely undulate-rugose below, nearly smooth at the apex, the inclosed palea striate. In the specimen examined the flowering glume has a prominent hippocrepiform scar at the base.

Australia.

A species previously referred to *C. macrostachya* (H. B. K.), but from which it is at once distinguished by its thicker panicles, broader leaves, narrowly ovate, larger spikelets, and more strongly rugose flowering glume.

†† *Branches loosely flowered.*

‡ *Flowering glume strongly transversely undulate-rugose.*

§ *Leaves pilose.*

21. **Chætochloa latifolia** Scribn. U. S. Dept. Agr., Div. Agros. Bul. **11**: 44, pl. 3 (1898). (Fig. 17.)

"A branching annual, 2 to 4 dm. high, with compressed sheaths, rather broad, flat leaves, and bristly panicles 4 to 8 cm. long. Culms compressed, slightly scabrous, and short bearded at the nodes; sheaths striate, scabrous, especially along the keel, papillate-pilose, villous on the overlapping margin; ligule very short and densely ciliate-fringed with stiff hairs; leaf-blades broadly lanceolate, cordate at the base, very acute, 5 to 6 cm. long, 1 to 2 cm. broad, scabrous on both sides and especially along the narrow, cartilaginous margins, strongly pilose above and below. Branches of the panicle very short, slightly crowded; setæ 12 to 18 mm. long, strongly antrorsely scabrous. Spikelets obovate, about 2 mm. long; first glume less than 1 mm. in length, 3-nerved; second glume shorter than the flowering glume, 5-nerved; outer glumes all obtuse, the third one empty; flowering or fruiting glume about 2 mm. long, strongly convex and deeply transversely rugose excepting near the slightly apiculate apex. Palea transversely rugose and similar in texture to the flowering glume.

"Growing under bushes in deep ravines, Durango, Mexico, 879 E. Palmer 1896.

"This species is well marked by its comparatively short and broad leaves, which are cordate at the base, and long, widely spreading bristles."

CHÆTOCHLOA LATIFOLIA BREVISETA var. nov.

A more slender form, with narrower, less pubescent leaves, which do not exceed 1 cm. in width, narrower, few-flowered panicles, and short appressed setæ.

Mexico.

Specimens examined.—*Mexico:* Oaxaca, 347 Conzatti & Gonzalez 1897; no locality, 470 Palmer 1896.

§§ *Leaves scabrous.*

22. **CHÆTOCHLOA LIEBMANNI** (Fourn.) n. comb. *Setaria liebmanni* Fourn. Mex. Pl. Enum. Gram. 44 (1886).

An erect, glabrous, yellowish-green annual, 3 to 9 dm. high, with broad, flat, soft leaves and loose, lanceolate panicles 1 to 2.5 dm. in length, 2 to 4 cm. in diameter. Culms erect, simple, or sometimes sparingly branched from the base, glabrous, straw colored; nodes glabrous or the lower ones with few appressed hairs; sheaths striate, loose, very glabrous, equaling or slightly exceeding the internodes, the margins cartilaginous, ciliate-fringed with short hairs; ligule short, densely ciliate-fringed with stiff white hairs about 1 mm. long. Leaf-blades lanceolate, somewhat narrowed at the cordate base, long acuminate-pointed, 1 to 3 dm. long, 1.5 to 2 cm. wide, thin, pale, scabrous on both sides and especially on the cartilaginous margins, midvein very prominent below, obscure above. Panicle attenuate at both ends, the axis slender, channeled, scabrous; branches approximate, erect-spreading, scabrous, slender, loosely few-flowered, 1.5 to 3 cm. long, much exceeding the internodes, not remote at the base; setæ one at the base of each spikelet, slender, flexuous, finely antrorsely scabrous, 10 to 15 mm. in length. Spikelets ovate, acute, 2 mm. long, pale, sometimes tinged with purple; first glume cordate, inclosing the base of the spikelet, acute, 3-nerved, one-third as long as the spikelet; second and third glumes broadly ovate, acute, 5 to 7 nerved, the second four-fifths as long as the spikelet, the third slightly exceeding the flowering glume, nerves green, prominent; flowering glume about 2 mm. long, ovate, acute, short-apiculate, strongly convex, striate, very strongly transversely undulate-rugose except near the apex; palea similar in texture and markings to the flowering glume.

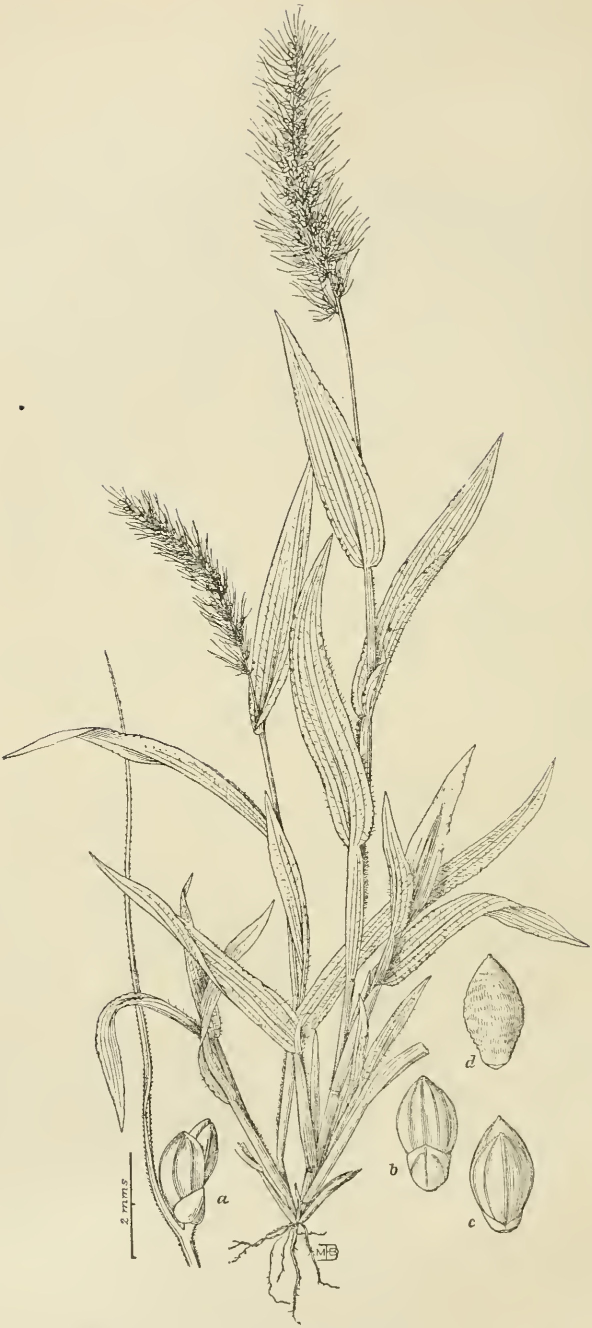

FIG. 17.—*Chætochloa latifolia:* *a*, spikelet showing the seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

In thickets, Mexico. July–October.

Specimens examined.—*Mexico:* Southwestern Chihuahua, 52 (in part) E. Palmer 1885; E. Palmer 1876; no locality, 233 Palmer 1897; Colima, 142 E. Palmer 1897; Oaxaca, 2788 Nelson 1895; Batopilas, 52, 110*a* Palmer 1885.

Readily distinguished by its yellowish-green color, broad, lanceolate, thin leaves, loose panicles, the branches not remote at the base, and its very strongly rugose flowering glumes.

CHÆTOCHLOA LIEBMANNI PAUCIFLORA (Vasey) n. comb. *Chamæraphis caudata pauciflora* Vasey in Beal Grasses of N. Am. 2: 158 (1896).

A very slender form, 1 to 4 dm. high, with much smaller, narrow panicles 1 cm. in diameter, 5 to 10 cm. long, the branches not exceeding 1 cm. in length or obsolete, and smaller leaves 5 to 10 cm. long, 3 to 10 mm. broad. Spikelets as in the type.

Mexico and Lower California.

Specimens examined.—*Mexico:* Southwestern Chihuahua, 52 (in part) Palmer 1885; Guaymas, 191 Palmer 1887; Alamos, 686 Palmer 1890. *Lower California:* San José del Cabo, 12 Brandegee 1890.

In habit very much resembling *Chætochloa grisebachii* (Fourn.), but at once distinguished by its very strongly rugose flowering glumes. *Chamæraphis caudata* (Lam.) Beal, Grasses of N. Am. 2: 157, to which this form was wrongly referred as a variety, is not true *Panicum caudatum* Lam., but *Chætochloa composita* (H. B. K.), to which the above is not closely related.

‡‡ *Flowering glume smooth or finely transversely wrinkled.*

§ *Spikelets 3 mm. long.*

23. **CHÆTOCHLOA MACROSPERMA** sp. nov. *Setaria composita* of Chapman's Fl. So. U. S. and of Bul. 7: 85. fig. 67, U. S. Dept. Agr., Div. Agros., not of H. B. K. (Fig. 18.)

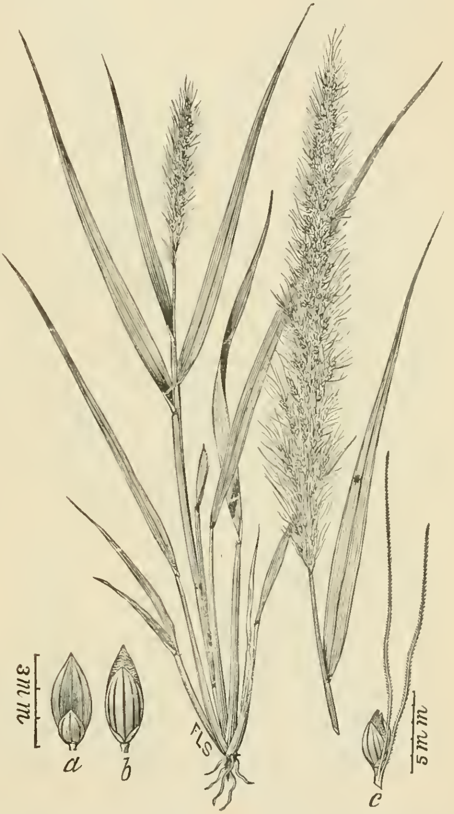

Fig. 18.—*Chætochloa macrosperma: a, b,* views of the spikelet; *c,* spikelet showing the setæ.

A very smooth, stout perennial, 6 to 12 dm. high, with broad, flat leaves and branching, bristly panicles 10 to 25 cm. long. Culms cylindrical, robust, geniculate at the base, glabrous; nodes smooth, sheaths compressed, striate, glabrous, the lower exceeding, the upper shorter than, their internodes, margins ciliate; ligule short, densely ciliate-fringed with long white hairs; leaf-blades linear-lanceolate, 1 to 3 dm. long, 10 to 20 mm. wide, somewhat narrowed at the base, and long slender acuminate at the apex, scabrous on both sides or sometimes nearly glabrous; margins cartilaginous, serrate-scabrous, midvein prominent below. Panicle linear-ovate in outline, 2 to 4 cm. in diameter exclusive of the awns;

rachis angular, striate, sparingly villous; branches erect-spreading, the lower ones 1.5 to 3 cm. long, loosely flowered; setæ solitary, 1.5 to 3 cm. long, green, somewhat flexuous, antrorsely scabrous. Spikelets short pedicellate, narrowly ovate, acute, 3 mm. long; first glume cordate, acute, inclosing the base of the spikelet; second glume oval, acute, short apiculate, 5 or rarely 7 nerved, three-fourths the spikelet in length; third glume 5-nerved, equaling the spikelet, slightly inclosing the flowering glume by its infolded edges, subtending a lanceolate, hyaline palea; flowering glume narrowly ovate, acute, striate, finely transversely undulate wrinkled, its palea similar in markings and texture, slightly convex at the base.

Shell islands and keys, sometimes in old fields. Florida, Texas. July–October.

Specimens examined.—*Florida:* Mouth of the St. Johns River, 3617 Curtiss; Key Largo, 5502 Curtiss 1895; Caloosa River, 41 Garber 1878; Orange Co., 29 Baker 1897; Weston Key, 263 Simpson 1891; Grasmere, 1150 Combs and Rolfs 1898; Cedar Key, 969 Combs 1898; Homosassa, 977 Combs 1898; Crystal, 979½ Combs 1898. *Texas:* Rio Grande, Wright 1848.

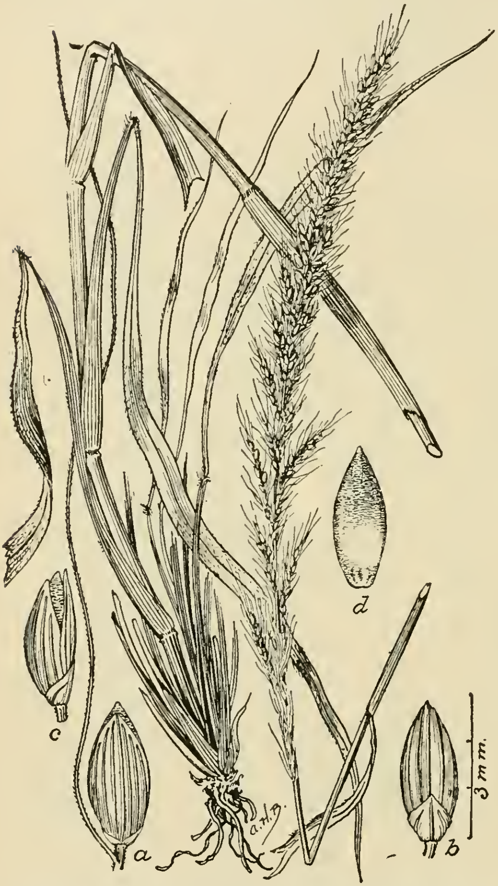

Fig. 19.—*Chætochloa villosissima: a*, spikelet showing the seta; *b, c*, views of the spikelet; *d*, flowering glume, dorsal view.

24. **CHÆTOCHLOA VILLOSISSIMA** sp. nov. (Fig. 19.)

An erect, somewhat cæspitose more or less densely villous-pubescent perennial, 4 to 10 dm. high, with broad-linear or linear-lanceolate leaves and loose, lanceolate panicles about 2 dm. in length. Culms branching and usually somewhat geniculate at the base, compressed, striate, glabrous; nodes smooth or sparingly bearded with appressed hairs; sheaths loose, striate, compressed, equaling or exceeding the internodes, scabrous above, especially on the keel, nearly smooth below, more or less densely villous-pubescent above, bearded at the apex and ciliate-pubescent on the margins; ligule brown, about 1 mm. long, densely ciliate-fringed with long white hairs; leaf-blades broad-linear, 1.5 to 3 dm. long, 6 to 8 mm. wide, tapering toward the base, long-acuminate at the apex, more or less densely villous-pubescent on both sides, with spreading white hairs, serrulate-scabrous on the cartilaginous margins, midvein prominent on the lower surface for its whole length. Panicle about 2 dm. long, 2 to 3 cm. in diameter below, tapering to the apex, loose; rachis angular striate, scabrous, villous; branches slender, spreading-erect, the lower 2 to 3 cm. long, few-flowered, much exceeding their internodes; setæ solitary, green, slender, somewhat flexuous, antrorsely scabrous, 1.5 to 2.5 cm. in length. Spikelets lanceolate-ovate, acute, 2.5 to 3 mm. long, pale green; first glume one-third as long as the spikelet, broadly ovate, acute, 3-nerved, somewhat inclosing the base of the spikelet; second glume nearly equaling the flowering glume, ovate, acute, short apiculate, 5 to 7 nerved, the midnerve excurrent, the lateral ones abruptly vanishing in the hyaline margins or anastomosing; third glume equaling the flowering glume, 5-nerved, apiculate, slightly sulcate and inclosing the flowering glume with its infolded margins subtending a very short lanceolate, hyaline palea about one-fifth its own length; flowering glume lanceolate-ovate, acute, abruptly short-apiculate at the incurved tip, rather finely transversely undulate-rugose below, striate and punctate above, the inclosed palea narrow, plane, similar in texture and markings.

Type specimen collected by J. G. Smith at San Diego, Tex., May, 1897. Limpia Canyon, Presidio Co., 115 (in part) Nealley 1892, a smaller undeveloped specimen, with much less pubescent leaves, otherwise as in the type.

A very distinct species, at once distinguished from *C. macrostachya* (H. B. K.) Scribn. and *C. composita* (H. B. K.) Scribn. by its loose, open panicle, larger spikelets, and narrow pubescent leaves, and from *C. macrosperma* by its more open panicle and narrow pubescent leaves.

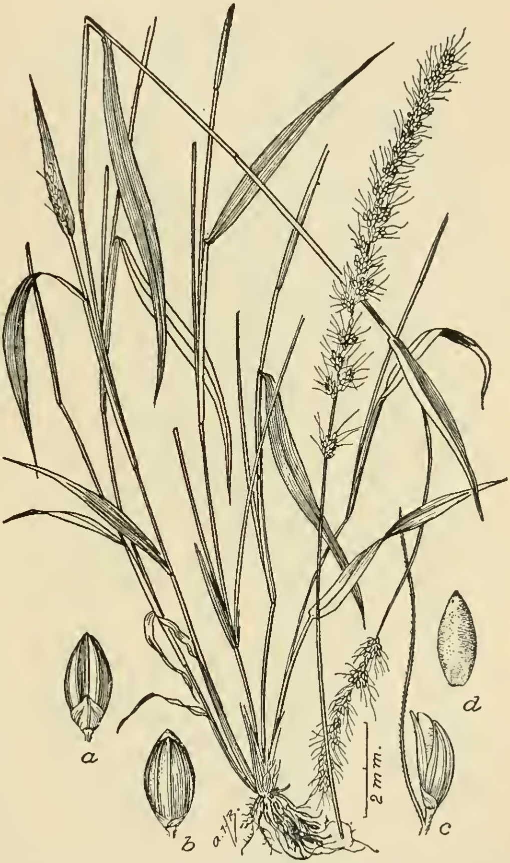

FIG. 20.—*Chætochloa grisebachii: a, b, c,* views of the spikelet; *d,* flowering glume, dorsal view.

§ § *Spikelets less than 3 mm. long.*

† *Flowering glume pitted or striate.*

25. **Chætochloa grisebachii** (Fourn.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. 4: 39 (1897). *Setaria grisebachii* Fourn. Mex. Pl. Enum. Gram. 45 (1886). (Fig. 20.)

A smooth, slender, cæspitose annual, 1.5 to 8 dm. high, with loose, compressed sheaths, short, lanceolate leaves and loose, bristly, panicles 3 to 12 cm. long. Culms branching at the base, very slender, glabrous, generally somewhat geniculate below; nodes bearded with short appressed hairs; sheaths shorter than the internodes, striate, open at the throat, scabrous, sparingly strigose-pubescent, margins ciliate; ligule short, densely ciliate-fringed; leaf-blades lanceolate, slightly narrowed at the cordate base, acuminate, 5 to 10 cm. long, 5 to 10 mm.

wide, scabrous and sparingly short pubescent on both sides, midvein prominent below, becoming obsolete above. Axis of the inflorescence angular, pilose, branches very short, appressed, few-flowered, the lower remote; setæ single or in pairs, somewhat flexuous, widely spreading, purple or sometimes green, 5 to 15 mm. long. Spikelets ovate, acute, 2 mm. long; first glume broadly cordate, inclosing the base of the spikelet, acute, 3-nerved, one-third as long as the spikelet; second glume obtuse, 5 to 7 nerved, nearly equaling the spikelet in length and closely enveloping it; third glume obtuse, 5-nerved, slightly exceeding the flowering glume in length, sulcate, subtending a short hyaline palea; nerves in all the glumes green, prominent; flowering glume nearly 2 mm. long, ovate, acute, nearly smooth, striate, and very finely transversely wrinkled below.

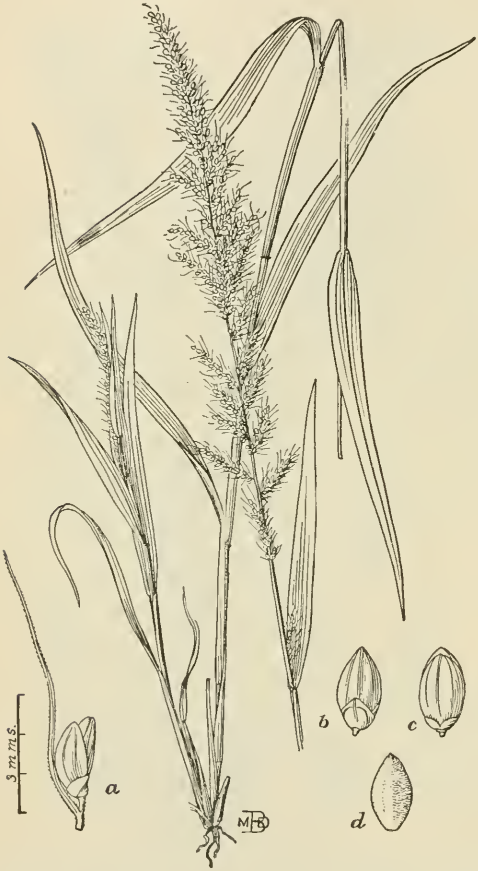

Fig. 21.—*Chætochloa grisebachii ampla:* *a*, spikelet showing the seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

Texas to Arizona. Mexico.

Specimens examined.—*Texas:* Austin, Hall 1872; no locality, Nealley 1888; Kerrville, Smith 1897; Heller 1894; Limpia Canyon, Presidio Co., 130 Nealley 1892; Smith 1897; Val Verde, Nealley 1890. *New Mexico:* 2096 Wright 1851–52, and 800 Wright 1849, no locality; Mangos, Smith 1897. *Arizona:* Bowie, 4288 Jones 1884; Camp Crittenden, Rothrock 1874; Beaver Creek, 606 McDougal 1891; Clear Creek, 78 Toumey 1891. *Mexico:* City of Mexico, 3040, 3153 Holway 1898; Rio Honda, Holway 1896; Chihuahua, 381 Pringle 1885; San Luis Potosi, 957 Parry & Palmer 1878; Oaxaca, 4937 Pringle 1894; no locality, 716 Palmer 1896, 1043 Schaffner 1876, 441 Bourgeau 1863–1866; Guanajuato, Dugès 1894.

No. 441 Bourgeau, represented in the Gray Herbarium, is cited by Fournier in the original description as one of the type specimens on which this species is based.

CHÆTOCHLOA GRISEBACHII AMPLA var. nov. (Fig. 21.)

A very robust form, 5 to 8 dm. high, with thicker culms, longer leaves, and long open panicles; leaves lanceolate, 1 to 2 dm. in length, 10 to 15 mm. wide; panicle loose, 12 to 18 cm. long, 2 to 5 cm. in diameter, the branches spreading, much longer than the internodes, the lower 2 to 3.5 cm. in length.

New Mexico; Mexico.

Specimens examined.—*New Mexico:* Organ Mountains, Vasey 1881; no locality, 994 Fendler 1847. *Mexico:* no locality, 4670 Pringle 1896; San Bernardino ranch, Mexican boundary, 2000 Mearns 1893; no locality, 728 Palmer 1896; Oaxaca, 344 Conzatti & Gonzalez 1897.

Readily distinguished from the type by its larger size and elongated, spreading branches of the panicle.

CHÆTOCHLOA GRISEBACHII MEXICANA var. nov. *Setaria mexicana* Schaffner in Herb.

A densely cæspitose form, 6 to 10 cm. high, with interrupted panicles 1 to 3 cm. long and short leaves 2 to 3 cm. in length. Spikelets as in the type.

San Luis Potosi, 1044 Schaffner 1876; Schaffner, Sept., 1877.

‡ *Flowering glume finely transversely wrinkled.*

= *Panicle obtuse at the apex.*

26. **CHÆTOCHLOA POLYSTACHYA** (Scheele) n. comb. *Setaria polystachya* Scheele, Linnæa **22:** 339 (1849). (Fig. 22.)

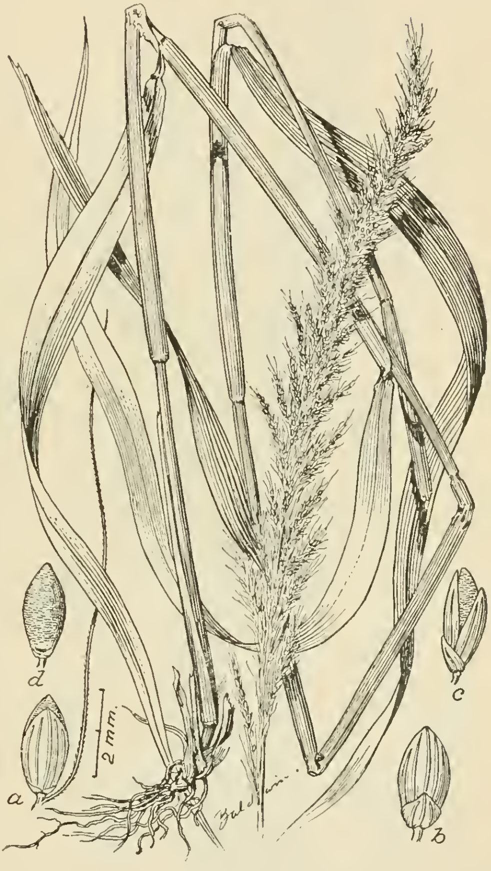

FIG. 22.—*Chætochloa polystachya:* *a*, spikelet showing the seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

A stout, erect perennial, 6 to 12 dm. high, with compressed culms, lanceolate leaves, and loose elongated panicles 1 to 2 dm. in length. Culms cylindrical or subcompressed, branching at the base, geniculate, glabrous or slightly scabrous below the nodes and panicle; nodes brown, bearded with short appressed hairs; sheaths striate, glabrous or slightly pubescent above, bearded at the apex, margins ciliate, the lower ones subcompressed, more or less scabrous on the keel; ligule short, ciliate-fringed; leaf-blades 1.5 to 3 dm. long, 1.5 to 2 cm. wide, abruptly narrowed at the base, acuminate, scabrous on both sides and especially so on the cartilaginous margins, the lower ones often more or less strigose-pubescent, midvein prominent below, becoming obsolete above. Panicle pale green, lanceolate, lax, 1.5 to 2.5 dm. long, 1.5 to 3 cm. in diameter; rachis angular, pilose, branches slender, 1.5 to 3 cm. long, erect-spreading, much exceeding their internodes; setæ solitary, 8 to 12 mm. long, green, slender, flexuous, antrorsely scabrous. Spikelets narrowly ovate, acute, 2 mm. long; first glume about one-third as long as the spikelet, slightly inflated, triangular-cordate, acute, 3-nerved; second glume two-thirds as long as the spikelet, acute, 5-nerved, the midnerve excurrent, the lateral ones anastomosing with it; third glume equaling the flowering glume, slightly sulcate, acute, 5-nerved, subtending a linear-lanceolate, hyaline palea; flowering glume narrowly ovate, acute, short-apiculate, striate, quite strongly transversely undulate-rugose below, striate or pitted at the apex, the inclosed palea narrowly ovate, slightly convex at the base, plane above, striate.

Dry soil, in thickets, etc., Texas. July–October.

Specimens examined.—*Texas:* Reverchon 1885; Nealley 1888; 164, 564 Lindheimer 1846; 357 Lindheimer 1845; Kerrville, Smith 1897; Gillespie Co., 783 Jermy; Mouth of Pecos River, 34 Havard 1883.

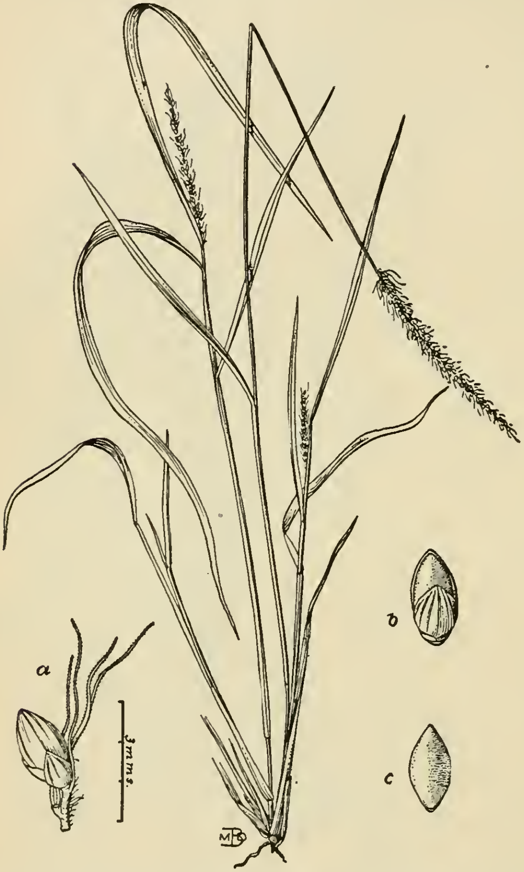

Fig. 23.—*Chætochloa caudata:* *a*, branch showing spikelet and setæ; *b*, view of the spikelet; *c*, flowering glume, dorsal view.

≐ = *Panicle long-attenuate at the apex.*

27. **Chætochloa caudata** (Lam.) Scribn. Rept. Mo. Bot. Gard. **10**: 52 (1899). *Panicum caudatum* Lam. Illus. **1**: 171 (1791). *Setaria caudata* R. & S. Syst. **2**: 495 (1817). (Fig. 23.)

A very slender, somewhat cæspitose annual 3 to 6 dm. high, with elongated, interrupted panicles and narrow, linear leaves 1 to 2.5 dm. in length. Culms much branched from the base, geniculate, glabrous, cylindrical, very slender; nodes smooth; sheaths about equaling the internodes, pubescent, ciliate on the margins; ligule short, ciliate. Leaf-blades linear, 1 to 2.5 dm. long, 3 to 5 mm. wide, pubescent on both sides, slightly scabrous on the midvein and margins, long filiform-attenuate at the apex, the upper ones generally equaling or exceeding the culms. Panicles 5 to 15 cm. long, attenuate, few-flowered; rachis slender, flexuous, angular, pilose; branches very short, not exceeding 5 mm., or obsolete; setæ solitary, flexuous, 4 to 10 mm. long, antrorsely scabrous, sometimes somewhat pilose below. Spikelets ovate, acute, short-pedicellate; first glume nearly one-half as long as the spikelet, ovate, acute, 5-nerved; second glume two-thirds the length of the spikelet, broadly ovate, acute, short apiculate, 5 to 7 nerved; third glume equaling the spikelet, 5-nerved; flowering glume ovate, acute, short apiculate, striate, transversely undulate-rugose below, smooth at the apex.

New Jersey, Alabama, and Florida, West Indies, Mexico, South America.

Specimens examined.—*New Jersey:* Camden, Martindale 1879, on "ballast." *Alabama:* Mobile, Mohr 1891, on "ballast." *Florida:* Key West, Blodgett. *West Indies:* St. Croix, 67 Ricksecker 1895.

The specimen from New Jersey is depauperate, being but slightly over 1 dm. high and densely caespitose.

28. **Chætochloa setosa** (Sw.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 37 (1897). *Panicum setosum* Swartz, Prod. Veg. Ind. Occ. 22 (1788). *Setaria setosa* Beauv. Agrost. 51 (1812). *Chamæraphis setosa* Kuntze Rev. Gen. Pl. **2**: 769 (1891). (Fig. 24.)

An erect branching perennial, 4 to 7 dm. high, with loose, slender, generally long-attenuate panicles 1 to 2.5 dm. in length and linear-lanceolate, pubescent leaves 1 to 2 dm. long. Culms rather slender, glabrous, geniculate at the base, cylindrical or subcompressed, sometimes rooting at the lower nodes; nodes glabrous; sheaths generally equaling or longer than the internodes, loose, striate, nearly smooth at the base, more or less pubescent toward the apex, ciliate on the margins; ligule very short, ciliate; leaf-blades linear-lanceolate, about 1 cm. broad, acuminate, rounded at the base, scabrous on the cartilaginous margins. Panicle lax, attenuate, 1 to 2 cm. in diameter; axis angular, pilose; branches slender, few-flowered, 1 to 2.5 cm. in length, equaling or exceeding the internodes; setæ 1 to 3 at each spikelet, slender, flexuous, scabrous, 10 to 15 mm. long; spikelets 2 mm. long, elliptical-ovate, acute; first glume about one-half the length of the spikelet, acute or acuminate, 3-nerved; second glume nearly equaling the spikelet, ovate, acute, abruptly apiculate, 5-nerved; third glume equaling the fourth, 5-nerved, subtending a hyaline palea which nearly equals the flowering glume in length; flowering glume about 2 mm. long, narrowly ovate, acute or acuminate, finely transversely rugose, especially below. Palea similar in markings and texture, equaling the glume in length.

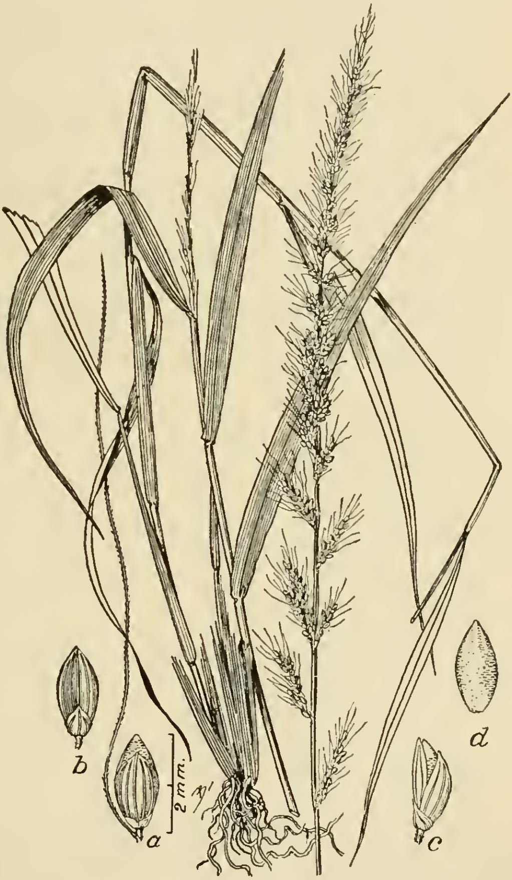

FIG. 24.—*Chætochloa setosa:* *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

New Jersey, New Mexico, West Indies, Mexico, South America.

SPECIMENS EXAMINED.—*New Jersey:* Camden, Parker 1879, on "ballast;" also collected by Martindale, no date. *New Mexico:* Organ Mountains, 438 Wooton 1897. *West Indies:* Kingston, Jamaica; Alexander 1853; March 1886, no locality; spikelets from specimen in Kew Herbarium, cited by Grisebach Fl. Brit. W. Ind. 555; same also in the Gray Herbarium, Cambridge; St. Croix, Eggers 1876; St. Thomas, Eggers 1876 and 1890; Gordon Town, 829 Hart 1886. *Mexico:* Monterey, Nuevo Leon, 1968 Pringle 1888.

The specimen from New Mexico, 438 Wooton 1897, is not typical and differs from the other specimens cited in having the sheaths somewhat compressed, slightly keeled, the setæ longer, and the panicle obtuse at the apex, not long-attenuate.

In H. B. K. Nov. Gen. & Sp. Pl. 1: 110 (1815) this species is cited as a synonym of *Setaria macrostachya*, but from a careful comparison of the original descriptions, authentic specimens, and the literature on the subject they appear to be very distinct. Nees[1] says that Swartz's specimens, which he has seen in the Schreber Herbarium, differ from *S. macrostachya* H. B. K. in having the second glume 5-nerved, narrower, pubescent leaves, and lax, elongated, and attenuated panicles. Trinius[2] says that the details of *Panicum setosum*[3] do not belong to this species, but to *P. onurum*, which has been confounded with it; hence the confusion regarding this species.

NORTH AMERICAN GRASSES WHICH HAVE BEEN WRONGLY REFERRED TO THE GENUS CHÆTOCHLOA (SETARIA).

Setaria auriculata Fourn. Mex. Pl. Enum. Gram. 43 (1886) =*Setariopsis auriculata* (Fourn.) Scribn.

Setaria cirrhosa Fourn. Mex. Pl. Enum. Gram. 43 (1886)=**Panicum cirrhosum** (Fourn.) n. comb.

Setaria effusa (Fourn.) Mex. Pl. Enum. Gram. 42 (1886)=**Panicum mexicanum** nom. nov.

Setaria jurgensenii Fourn. Mex. Pl. Enum. Gram. 42 (1886)=**Panicum jurgensenii** (Fourn.) n. comb.

Setaria latiglumis Vasey Bul. Torr. Bot. Club. **13**: 229 (1886)=*Setariopsis latiglumis* (Vasey) Scribn.

Setaria paniculifera (Steud.) Fourn. Mex. Pl. Enum. Gram. 42 (1886)=*Panicum paniculiferum* Steud. Syn. Gram. 54. 1855.

Setaria pauciseta Vasey Bul. Torr. Bot. Club **13**: 230 (1886)=*Setariopsis auriculata* (Fourn.) Scribn.

Setaria schiedeana (Schlecht.) Fourn. Mex. Pl. Enum. Gram. 43 (1886)=*Ixophorus schiedeana* Schlecht. Linnæa **31**: 421 (1861).

Setaria sulcata Raddi Agrost. Bras. 50=*Panicum sulcatum* Aubl.

Setaria uniseta (Presl) Fourn. Mex. Pl. Enum. Gram. 43 (1886)=*Ixophorus unisetus* Schlecht. Linnæa **31**: 421 (1861).

Chamæraphis uniseta of Beal's Grasses of N. Am. **2**: 158 (1896) is *Chætochloa grisebachii.*

DOUBTFUL AND UNKNOWN SPECIES CREDITED TO NORTH AMERICA.

Setaria affinis Schrad. in R. & S. Mant. **2**: 276 (1824), Described by Muhlenberg in Desc. Gram. 101 (1817) without name=(?) *Chætochloa corrugata parviflora.* Southern States.

Setaria ambigua Schrad. Linnæa **12**: 430 (1838). Type material collected in Texas=(?) *Chætochloa imberbis geniculata.*

Setaria biconvexa Grisebach Fl. Brit. W. Ind. 555 (1864). Scarcely distinct from *C. onurus.* Spikelets from Grisebach's type specimen sent from Kew Herbarium agree almost perfectly with those of *C. onurus.* *S. biconvexa* is described as having the second glume 7-nerved as a distinguishing character from the 9 to 11 nerved second glume of *S. onurus*, but the spikelets from Grisebach's type have the second glume 9-nerved!

---

[1] Agrost. Bras. **2**: 246.

[2] Mem. Acad. Sci. St. Petersb., ser. 6, **3**: 138, 139.

[3] Trin. Icon. t. 95.

Setaria californica Kellogg Proc. Cal. Acad. Sci. **1**: 26 (1873). Collected at Shasta, on the Sacramento River, and described as being about 12 feet high, with erect, cylindrical spikes a foot long, with densely villous rachis, and smooth flowering glume. From the description and the fact that this prominent form has not been collected since, there can be little doubt that it was a form of *Chætochloa italica*, escaped from cultivation but not persisting.

Setaria falcifolia Fourn. Mex. Pl. Enum. Gram. 44 (1886). Mexico.

Setaria flava Kunth, Rev. Gram. **1**: 46 (1829). Described from South American material and credited by Fournier to Mexico. No specimens have been seen which agree with Kunth's description, and the specimens cited by Fournier (231 Bourgeau and 30 Liebmann), which were examined, are referable to *C. purpurascens*.

Setaria lævis Fourn. Mex. Pl. Enum. Gram. 45 (1886). Mexico.

Setaria pseudoverticillata Fourn. Mex. Pl. Enum., 45 (1886). Mexico.

Setaria rariflora Presl Rel. Hænk. **1**: 313 (1830). Mexico.

Setaria semirugosa Kunth Enum. Pl. **1**: 152 (1833). Described from South American material and credited by Fournier to Mexico. No specimens seen from North America.

Setaria stipæculmis C. Mueller Bot. Zeit. **19**: 323 (1861). This is certainly not a *Setaria*, as is very evident from the original description. Texas.

Setaria vulpiseta R. & S. Syst. **2**: 495 (1817). Credited by Grisebach to the West Indies. No specimens seen. Fournier (Mex. Pl. Enum. Gram. 45) says that the specimens referred by Grisebach to *S. vulpiseta* are *S. macrostachya* H. B. K.

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Bulletin No. 22. Agros. 62.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

LIBRARY,
NEW YORK
BOTANICAL
GARDEN.

COOPERATIVE EXPERIMENTS WITH GRASSES AND FORAGE PLANTS.

BY

P. BEVERIDGE KENNEDY, Ph. D.,
Expert and Agent in Charge of Experimental Work.

PREPARED UNDER THE DIRECTION OF F. LAMSON-SCRIBNER, AGROSTOLOGIST.

1862 1889

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

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1896. Cowpeas. (Reprinted and published as Farmers' Bulletin No. 89.)
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1897. Leguminous Forage Crops.
1898. Sand-binding Grasses.
1898. Forage Plants for Cultivation on Alkali Soils.
1898. Millets. (Reprinted and published as Farmers' Bulletin No. 101.)

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1900.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Agrostology,
Washington, D. C., January 22, 1900.

Sir: I have the honor to transmit herewith, and recommend for publication as Bulletin No. 22 of this Division, a report on the cooperative experiments carried on during the past three years, prepared under my direction by Dr. P. Beveridge Kennedy, expert in charge of experimental work. During this period seeds of 251 varieties of grasses and forage plants, making nearly 10,000 packages, have been distributed by the Division. Five thousand one hundred and twenty packages have been sent to those whom we term our volunteer experimenters, nearly 3,000 to the agricultural experiment stations, and 1,110 packages have been sent to stations in foreign countries. Two of these stations—one in Cape Colony, South Africa, and one in Australia—have already published interesting reports upon the results obtained from the seeds sent them, and several of our agricultural experiment stations have made the results secured from cultivation of the seeds obtained through this Division the basis of important reports. These distributions have incited a wide-spread and marked interest in a subject of great financial importance to every farmer and stock owner in the country, and while we know our work along these lines has been of direct benefit to many individuals, we are equally confident that the investigations now being carried on and partially noted in this report will advance and improve the farming and grazing interests of the entire country. The report here presented is based almost entirely upon the reports of our volunteer experimenters, and will be of special interest on account of the fact that the testimony given comes directly from the practical farmer.

Respectfully, F. Lamson-Scribner,
Agrostologist.

Hon. James Wilson,
Secretary of Agriculture.

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COOPERATIVE EXPERIMENTS WITH GRASSES AND FORAGE PLANTS.

INTRODUCTION.

The interest in the introduction of useful grasses and forage plants is increasing throughout the country every year. Daily applications are received from farmers who desire to cooperate with the Division in the important work of introduction and trial of new or untried varieties. Thus is created a greater demand for certain varieties which might never have been brought into cultivation except by the efforts of the Department of Agriculture. For example, the smooth brome grass, hairy vetch, Turkestan alfalfa, velvet bean, sulla, Metcalfe bean, slender wheat grass, Western wheat grass, Japanese barnyard millet, and many others may be cited.

The main object is to introduce into cultivation native and foreign varieties of grass and forage plants that are suitable for certain purposes or conditions. Some plants have been found to be excellent drought-resisters; others, on account of their strong, creeping rootstocks, are found to be well adapted to bind the drifting sands of our coasts and lake shores, while still others have the power to resist the trampling of stock and are valuable for reclaiming the cattle ranges of the great West. Demands come from the South, where the land has become exhausted by continuous growing of cotton, for forage plants that will restore the fertility of the soil. There are large tracts of land in the country where the soil is so alkaline that the cultivated grasses will not grow on them. By the introduction of saltbushes on these lands a nourishing forage can be produced which is liked by all kinds of stock. Other requests are made for trial packages of seed suitable for lawns, golf links, fair grounds, and parks in all sections of the United States. The climate and soil conditions of the country are so varied that much study, observation, and experimentation is necessary in order to meet the needs of the different sections and to carry on a wise, useful, and economical distribution.

Since 1896 this Division has distributed 5,120 packages of seed, including 251 varieties of grasses and forage plants, to volunteer experimenters, 2,927 packages to experiment stations and universities, and 1,110 packages to foreign countries, making a total of 9,157 packages.

Farmers to the number of 1,713 in all parts of the United States have complied with the request for a report as to their success or failure with these seeds. We desire here to acknowledge and to thank all those kindly filling out the blanks forwarded to them, thus making possible the production of this report.

This distribution does not include large consignments of grass and forage plant seeds sent to our special agents at Walla Walla, Wash., Abilene, Tex., and Highmore, S. Dak. The detailed reports from these stations on the results obtained are published in Circulars 21, 22, and 23 of the Division of Agrostology.

SEED DISTRIBUTION TO VOLUNTEER EXPERIMENTERS.

Trials of new grasses and forage plants are necessary that ranchers and farmers in all parts of the country may determine their suitability each for his own district. After selection of the promising varieties has been made they can be grown on a larger scale and finally adopted without the useless expenditure of time, money, and labor often attending attempts to grow new forage crops. This introduction of new grasses and the improvement of those already in cultivation is very necessary and important. Many of the ranges have been overstocked and require renewing, and it is a serious question as to what are the best grasses with which to reseed them.

Experiments, to be properly carried on, must receive careful attention; occasional examinations of the plats must be made and the rate of growth and progress carefully noted, so that at the close of the season one can select the varieties that are worthy and suitable for the locality.

During the last three fiscal years 5,120 packages of grass and forage plant seeds, including 251 different varieties, have been distributed by this Division to volunteer experimenters throughout the United States. Table I indicates the variety and the number of packages distributed during the fiscal years 1896–97, 1897–98, 1898–99.

Some of the varieties which have been distributed extensively are Turkestan alfalfa, blue grama, bur clover, dwarf Essex rape, hairy vetch, Japanese barnyard millet, meadow fescue, Metcalfe bean, Russian red clover, rescue grass, Rhode Island bent grass, shad scale, smooth brome grass, slender wheat grass, side oats grama, soy beans, sorghum, sulla, velvet bean, Virginia lyme grass. The seed is obtained for the Division mainly through special agents, who go out into the field during the summer months and collect the seed of those native varieties which by their habit of growth and general appearance seem likely to prove valuable under cultivation. A considerable quantity of seed is also grown at the experiment stations at Walla Walla and Yakima, Wash., and large quantities of a few varieties from foreign countries have been distributed directly by the Division or through the Section of Seed and Plant Introduction.

Table I.—*Number of packages and varieties of grass and forage plant seeds distributed to experimenters, and number and kinds of reports of experiments received.*

No.	Variety.	Number of trial packages distributed to experimenters.				Number and kind of reports received from experimenters.				
		Fiscal year—								
		1896–97.	1897–98.	1898–99.	Total.	Failures.	Unsatisfactory.	Good.	Excellent.	Total.
1	African millet (Eleusine corocana)	....	1	2	3	1	2	....	....	3
2	Agropyron acutum	....	1	2	3	....	....	....	....	......
3	Agropyron dasystachyum	....	....	1	1	....	....	....	....	......
4	Agropyron dasystachyum subvillosum	....	....	2	2	....	....	....	....	......
5	Agropyron rigidum	....	....	1	1	....	....	....	....	......
6	Alfalfa (Medicago sativa)	50	366	159	575	99	27	94	18	148
7	Alkali saccaton (Panicum bulbosum)	....	1	2	3	....	....	....	....	......
8	Alpine timothy (Phleum alpinum)	....	....	....	....	....	....	....	....	......
9	Alsike clover (Trifolium hybridum)	1	22	....	23	....	3	1	....	4
10	American lyme grass (Elymus americanus)	....	2	2	4	1	....	....	....	1
11	American reed bent (Calamagrostis americana)	....	....	....	....	....	....	....	....	......
12	Andropogon annulatus	....	4	....	4	1	1	....	....	2
13	Andropogon laniger	....	3	....	3	....	....	....	....	......
14	Andropogon pertusus	....	3	....	3	....	....	....	....	......
15	Andropogon saccharoides	....	1	....	1	....	....	....	....	......
16	Andropogon schœnanthus	....	1	....	1	....	....	....	....	......
17	Andropogon scoparius	....	1	....	1	....	....	....	....	......
18	Andropogon squarrosa	....	5	....	5	2	....	....	....	2
19	Androsace occidentalis	....	2	....	2	....	....	....	....	......
20	Annual saltbush (Atriplex holocarpa)	1	2	26	29	6	....	1	....	7
21	Apluda cristata	1	....	....	1	....	....	....	....	......
22	Atriplex angulata	....	....	3	3	....	....	....	....	......
23	Australian saltbush (Atriplex semibaccatum)	13	2	3	18	7	....	1	....	8
24	Bearded wheat grass (Agropyron caninum)	....	1	13	14	7	....	1	....	8
25	Bermuda grass (Cynodon dactylon)	1	12	9	22	3	2	5	....	10
26	"Best all round grass"	....	....	3	3	....	....	....	....	......
27	Bladder saltbush (Atriplex vesicaria)	2	3	....	5	....	....	....	....	......
28	Black grama (Hilaria mutica)	....	4	3	7	1	....	....	....	1
29	Blue joint grass (Calamagrostis canadensis)	1	....	....	1	....	....	....	....	......
30	Blue grama (Bouteloua oligostachya)	51	3	16	70	5	3	6	....	14
31	Bowie grass (Panicum effusum)	....	....	3	3	....	....	....	....	......
32	Big blue stem (Andropogon provincialis)	....	6	5	11	....	....	....	....	......
33	Bouteloua mixture	....	....	5	5	....	....	....	....	......
34	Broad-leafed spike grass (Uniola latifolia)	....	1	1	2	....	....	....	....	......
35	Brown's lyme grass (Elymus innovatus)	....	1	....	1	....	....	....	....	......
36	Bromus maximus	....	1	1	2	....	....	....	....	......
37	Bromus pumpellianus	....	1	....	1	....	....	1	....	1
38	Buffalo grass (Bulbilis dactyloides)	2	6	3	11	3	....	3	....	6
39	Buffalo bunch grass (Festuca scabrella)	....	....	1	1	....	....	....	....	......
40	Bunch red top (Poa buckleyana)	....	2	11	13	....	....	....	....	......
41	Bunch spear grass (Poa arida)	....	1	....	1	....	....	....	....	......
42	Bunch wheat grass (Agropyron divergens)	....	....	11	11	....	....	....	....	......
43	Bur clover (Medicago maculata)	....	1	29	30	3	2	2	....	7
44	Bunshy blue stem (Andropogon nutans)	....	....	3	3	1	2	1	....	4
45	Button grass (Dactyloctenium australiense)	....	....	3	3	1	....	....	....	1
46	Canadian blue grass (Poa compressa)	5	2	4	11	....	....	1	....	1
47	Canadian lyme grass (Elymus canadensis)	....	2	20	22	2	2	2	....	6
48	Calamagrostis sylvatica	....	....	1	1	....	....	....	....	......
49	Calamagrostis sp	....	....	1	1	....	....	....	....	......
50	Cane (Arundinaria macrosperma)	....	....	1	1	....	....	....	....	......
51	Capnoides aureum	....	1	....	1	....	....	....	....	......
52	Carex douglasii	....	1	....	1	....	....	....	....	......
53	Cenchrus biflorus	....	3	....	3	....	....	....	....	......
54	Chætochloa glauca	....	1	....	1	....	....	1	....	1
55	Chætochloa verticillata	....	1	....	1	....	....	....	....	......
56	Chick pea (Cicer aretinum)	....	....	1	1	....	....	....	....	......
57	Chichorium intybus	1	....	....	1	1	....	....	....	1
58	Chloris barbata	....	1	....	1	....	....	....	....	......

Table I.—*Number of packages and varieties of grass and forage plant seeds distributed to experimenters, etc.*—Continued.

No.	Variety.	Number of trial packages distributed to experimenters.				Number and kind of reports received from experimenters.				
		Fiscal year—			Total.	Failures.	Unsatisfactory.	Good.	Excellent.	Total.
		1896–97.	1897–98.	1898–99.						
59	Chloris cucullata		1		1					
60	Crab grass (Eragrostis neo-mexicana)	2	1		3					
61	Crab grass (Panicum sanguinale)		1		1					
62	Creeping bent (Agrostis stolonifera)	2	13	19	34	9	1			10
63	Curly mesquit (Hilaria cenchroides)		7	11	18		1			1
64	Crimson clover (Trifolium incarnatum)	5	1	37	43	7	3	2		12
65	Crowfoot grass (Eleusine Egyptiaca)		2		2					
66	Colorado grass (Panicum texanum)			1	1		1	2		3
67	Cowpeas (Vigna catjang)	2	2		4	4		1	2	7
68	Cyperus rotundus (Nut grass)		1		1					
69	Deccan grass (Panicum frumentaceum)		9	2	11					
70	Desmodium biflorum		1		1					
71	Ditch millet (Paspalum scrobiculatum)		8	1	9	1				1
72	Dogtown grass (Aristida fasciculata)			1	1					
73	Downy brome grass (Bromus tectorum)		1		1			2	1	3
74	Dwarf Essex rape (Brassica napus)		1	60	61	2	2	2	6	12
75	Early bunch-grass (Eatonia obtusata)			1	1					
76	Eleusine stricta		1		1					
77	Elionurus hirsutus		2		2					
78	Elymus ambiguus		1		1					
79	Eragrostis cynosuroides		2		2					
80	Eragrostis stolonifera			1	1					
81	Eragrostis tremula		1		1					
82	Esparto grass (Lygeum spartum)	2	1	1	4					
83	Esparto grass (Stipa tenacissima)		1		1					
84	False quack grass (Agropyron pseudorepens)	1	1	5	7					
85	Fancy red top (Agrostis alba vulgaris)		2	5	7	2		3		5
86	Feather bunch grass (Stipa viridula)			9	9					
87	Festuca arundinacea		4	1	5					
88	Festuca fenas		1		1					
89	Festuca ovina tenuifolia			1	1					
90	Finger grass (Chloris elegans)			1	1					
91	Field peas (Pisum arvense)	2	2	15	19	4	1	2	1	8
92	Fine-top salt grass (Sporobolus airoides)		1	4	5					
93	Flat pea (Lathyrus sylvestris)	9			9	6	1	1	1	9
94	Florida beggar weed (Desmodium tortuosum)	2		1	3	2	1	1		4
95	Fowl meadow grass (Panicularia nervata)			1	1					
96	Foxtail millets (Chaetochloa italica)		29	2	31	1	4	7		12
97	Fresh-water cord grass (Spartina cynosuroides)		2	5	7	1				1
98	German millet (Chaetochloa italica var. germanica)	4			4					
99	Giant brome (Bromus giganteus)		1		1	2				2
100	Giant lyme grass (Elymus condensatus)		4	20	24	2	1	1		4
101	Gracilea royleana		1		1					
102	Gray saltbush	34			34	6	1			7
103	Hairy-flowered lyme grass (Elymus hirsutiglumis)		1	1	2					
104	Hairy vetch (Vicia villosa)	34	332	98	444	86	43	71	6	206
105	Hard fescue (Festuca duriuscula)	1	5	1	7	2	1			3
106	Hooker's brome grass (Bromus hookerianus)			4	4					
107	Hurrah grass (Panicum reticulatum)		4		4					
108	Imperata arundinacea	1			1					
109	Indian grass (Andropogon nutans avenaceum)	11			11					
110	Indian millet (Eriocoma cuspidata)		3	3	6					
111	Iseilema wrightii	1			1					
112	Italian rye grass (Lolium italicum)			20	20	4		1		5
113	Japan clover (Lespedeza striata)	1			1	1				1
114	Japanese barnyard millet (Panicum crus-galli)	7	12	59	78	14	5	10		29
115	Japanese lawn grass (Zoysia pungens)	4	2	1	7					
116	Jerusalem corn (Andropogon sorghum vulgaris)			12	12	3	1			4
117	Johnson grass (Andropogon halapense)	1	3		4	2		4		6
118	Kaffir corn (Andropogon sorghum vulgaris)			13	13	2	1	1		4

TABLE I.—*Number of packages and varieties of grass and forage plant seeds distributed to experimenters, etc.*—Continued.

No.	Variety.	Number of trial packages distributed to experimenters.				Number and kind of reports received from experimenters.				
		Fiscal year—								
		1896–97.	1897–98.	1898–99.	Total.	Failures.	Unsatisfactory.	Good.	Excellent.	Total.
119	Kentucky blue grass (Poa pratensis)		2	15	17	2				2
120	King's fescue (Festuca kingii)			10	10					
121	Koeleria valesiaca		1		1					
122	Langsdorff's reed bent (Calamagrostis langsdorffii)			6	6					
123	Lappula redouski		1		1					
124	Large water grass (Paspalum dilitatum)		1	2	3					
125	Leptochloa dubia		2	1	3					
126	Lentils (Ervum lens)	1	4	14	19		2	2		4
127	Lesquerella gordonii		1		1					
128	Lotus americanus		1		1					
129	Lupine (Lupinus sp.)			1	1					
130	Marram Grass (Ammophila arenaria)	3			3					
131	Meadow foxtail (Alopecurus pratensis)			14	14					
132	Medicago media		4	7	11					
133	Meadow fescue (Festuca pratensis)		387	37	424	46	18	44	3	101
134	Melica altissima			2	2					
135	Metcalfe bean (Phaseolus retusus)			22	22	1	2	3		6
136	Mitchell grass (Astrebla pectinata)		1		1					
137	Mixed sand grasses			2	2					
138	Mogollon vetch (Vicia sp.)	2	2		4	1				1
139	Mollugo verticillata		1		1					
140	Molinia coerulea			1	1					
141	Montana reed bent (Calamagrostis montanensis)			3	3					
142	Mountain spear grass (Poa alpina)		1	1	2					
143	Mungrove millets from South Africa		1		1					
144	Mutton grass (Poa fendleriana)		7	2	9					
145	Nelson's saltbush (Atriplex pabularis)		6		6					
146	Northern red top (Agrostis exarata)			4	4					
147	Northern spear grass (Poa nemoralis)			16	16					
148	Northern wheat grass (Agropyron violaceum)		2		2					
149	Nuttall's saltbush (Atriplex nuttallii)		4		4	1				1
150	Old man's saltbush (Rhagodia parabolica)	8			8	2				2
151	Orchard grass (Dactylis glomerata)	2			2	2			1	3
152	Oryza sativa			1	1					
153	Panicum decompositum		1		1					
154	Panicum floridanum		1		1					
155	Panicum hallii			1	1					
156	Panicum aveuaceum			2	2					
157	Panicum humile		3		3					
158	Panicum javanicum		1		1					
159	Panicum violaceum		1		1					
160	Panicum sanguinale		2		2					
161	Panicularia sp			1	1					
162	Poa flava		1		1					
163	Poa laevigata			18	18					
164	Poa wheeleri			3	3					
165	Poa sp			1	1					
166	Pasture mixture			9	9					
167	Purple reed bent (Calamagrostis purpurascens)			1	1					
168	Quack grass (Agropyron repens)			1	1					
169	Red clover (Trifolium pratense)		329	15	344	74	18	53	7	152
170	Red fescue (Festuca rubra)		7	21	28	4				4
171	Red lump millet (Panicum miliaceum)	15	345		360	63	37	60	6	166
172	Red top (Agrostis alba)	1	7	2	10	3		4		7
173	Reed canary grass (Phalaris arundinacea)	1		3	4					
174	Rescue grass (Bromus unioloides)	2		46	48	4	1	4	1	10
175	Rhode Island bent (Agrostes canina)	3	17	27	47	7		1		8
176	Richardson's wheat grass (Agropyron richardsonii)	1			1	1		1		2
177	Rocky mountain hair grass (Deschampsia caespitosa)	2	9		11					
178	Rough-stalked meadow grass (Poa trivialis)			1	1					
179	Round-leaved saltbush (Atriplex nummularia)	8			8	2	1			3
180	Saccaton (Muhlenbergia distichophylla)	10			10	6				6

Table I.—*Number of packages and varieties of grass and forage plant seeds distributed to experimenters, etc.*—Continued.

No.	Variety.	Number of trial packages distributed to experimenters.				Number and kind of reports received from experimenters.				
		Fiscal year—			Total.	Failures.	Unsatisfactory.	Good.	Excellent.	Total.
		1896–97.	1897–98.	1898–99.						
181	Saccaton (Sporobolus wrightii)			2	2					
182	Saccharum spontaneum		2		2					
183	Sand bur (Cenchrus tribuloides)			1	1					
184	Sainfoin (Onobrychis sativa),	1		17	18	2	1	2		5
185	Sand rush-grass (Sporobolus depauperatus)		1	2	3					
186	Sapling clover (Trifolium media)			19	19	1				1
187	Seaside blue grass (Poa macrantha)			18	18	4				4
188	Serradella (Ornithopus sativa)	2			2	1				1
189	Shad scale (Atriplex canescens)	78	5	2	85	11		10		21
190	Shama millet (Panicum colonum)		6		6	3				3
191	Short-awned brome (Bromus breviaristatus)		1	27	28			2		2
192	Sheep's fescue (Festuca ovina)		1	17	18	3				3
193	Side oats grama (Bouteloua curtipendula)	60	4	7	71	3	7	9		19
194	Silvery salt sage (Atriplex argentea)		4	8	12	2				2
195	Six weeks grama (Bouteloua polystachya)		3	3	6					
196	Slender-fruited saltbush (Atriplex leptocarpa)	18		3	21	6		1		7
197	Slender wheat grass (Agropyron tenerum)		49	40	89	7	7	14		28
198	Slough grass (Beckmannia erucaeformis)	1		7	8					
199	Smooth brome (Bromus inermis)	29	401	106	536	88	63	121	32	284
200	Smooth lyme grass (Elymus glaucus)		1	1	2					
201	Snail clover (Medicago turbinata)		2		2					
202	Southern canary grass (Phalaris caroliniana)		5	2	7					
203	Soy bean (Glycine hispida)	26	39	86	151	12	7	10	3	32
204	Spiny salt sage (Atriplex confertifolia)		7		7	2				2
205	Sporobolus arabicus	7			7	2				2
206	Sporobolus cryptandrus			3	3					
207	Sporobolus richardsoni	1			1					
208	Spongy saltbush (Atriplex spongiosum)	2			2					
209	Sorghum (Andropogon sorghum vulgaris)	24	23	16	63	9	3	12	7	29
210	Sprangle top (Scolochloa festucacea)			9	9					
211	Squirrel grass (Hordeum murinum)		1		1					
212	Stink grass (Eragrostis major)			1	1					
213	Stolley's vetch (Vicia leavenworthii)		8	2	10	4	1	1		6
214	Sulla (Hedysarum coronarium)			29	29	5		1		6
215	Swamp chess (Bromus ciliatus)			3	3					
216	Sweet clover (Melilotus alba)		1		1					
217	Switch grass (Panicum virgatum)			1	1					
218	Sysymbrium canescens		2		2					
219	Tall fescue (Festuca elatior)		4	10	14	2				2
220	Tall oat grass (Arrhenatherum elatius)		7	4	11			1		1
221	Teosinte (Euchlaena mexicana)		7	3	10	2		1		3
222	Teff (Eragrostis abyssiniea)		1	2	3					
223	Texas blue grass (Poa arachnifera)		1		1					
224	Texan grama (Bouteloua texana)		1	1	2					
225	Texan timothy (Lycurus pleoides)	6			6	1				1
226	Tetradynia canescens		1		1					
227	Timothy (Phleum pratense)		1		1					
228	Top grama (Bouteloua juncifolia)	21	2	1	24	1	1	7		9
229	Trifolium involucratum		1	6	7					
230	Tsama watermelon (Citrullus vulgaris)		1	2	3			2		2
231	Tweedy's feather grass (Stipa tweedyi)			5	5					
232	Twisted beard grass (Andropogon contortus)		2		2					
233	Uniola laxa		1		1					
234	Uniola longipipes		1		1					
235	Upright chess (Bromus racemosus)		1		1					
236	Utah saltbush (Atriplex truncata)	3			3					
237	Various-leaved fescue (Festuca heterophylla		12	4	16	1				1
238	Velvet bean (Mucuna utilis)		19	15	34	3	2	8	6	19
239	Velvet grass (Holcus lanatus)		1		1					
240	Veronica peregrina		1		1					
241	Virginia lyme grass (Elymus virginicus)	1	6	19	26	3	2	1		6
242	Western wheat grass (Agropyron spicatum)	1	7	22	30	4	1			5

TABLE I.—*Number of packages and varieties of grass and forage plant seeds distributed to experimenters, etc.*—Continued.

No.	Variety.	Number of trial packages distributed to experimenters.				Number and kind of reports received from experimenters.				
		Fiscal year—								
		1896-97.	1897-98.	1898-99.	Total.	Failures.	Unsatisfactory.	Good.	Excellent.	Total.
243	White clover (Trifolium repens)	....	1	6	7	....	....	....	....	......
244	Wild chess (Bromus kalmii)	....	1	3	4	....	....	1	....	1
245	Wild timothy (Muhlenbergia racemosa)	....	3	12	15	....	....	....	....	......
246	Windmill grass (Chloris verticillata)	....	....	1	1	....	....	....	....	......
247	Winter fat (Eurotia lanata)	35	4	....	39	10	1	....	....	11
248	Wyoming blue grass (Poa wheeleri)	....	....	3	3	....	....	....	....	......
249	Woolly bent grass (Calamovilfa longifolia	....	....	2	2	....	....	....	....	......
250	Woolly-jointed grama (Bouteloua eriopoda)	2	2	....	4	....	....	....	....	......
251	Yellow spear grass (Poa lueida)	....	1	5	6	....	....	....	....	......
	Total	632	2,749	1,739	5,120	718	287	607	101	1,713

SEED DISTRIBUTION TO EXPERIMENT STATIONS, BOTANICAL GARDENS, AND UNIVERSITIES.

An important work of the Division has been to supply the experiment stations throughout the United States with grass and forage-plant seeds for experimental purposes. Many of these varieties could not easily be obtained in any other way, as they are not on the market.

By examination of Table II it will be seen that during the last three fiscal years 2,927 packages have been distributed to 33 experiment stations, 2 universities, and 1 botanical garden. The stations receiving the largest number of varieties were those in Arizona, California, Iowa, Kansas, Nebraska, Ohio, Oregon, South Dakota, Tennessee. Texas, Washington, and Wyoming. These lots averaged 135 different varieties of grass and forage plants. The results of the experiments have not in all cases been reported to the Division, but were published in the various bulletins and reports of the stations, to which the reader is referred for detailed information.

The receipt of reports from the experiment stations of Alabama, Arizona, Georgia, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, Washington, Wyoming, Cornell University, and California is here acknowledged. The results of this distribution are now being compiled and will be published later as a separate report from this division.

Table II.—*Number of packages of grass and forage plant seeds distributed to experiment stations and universities.*

Experiment station or university.	Fiscal year.			Total.
	1896–97.	1897–98.	1898–99.	
Alabama Experiment Station, Auburn, Ala	17	1		18
Arizona Experiment Station, Tucson, Ariz	135			135
California Experiment Station, Berkeley, Cal	135	2	2	139
Florida Experiment Station, Lake City, Fla		1		1
Georgia Experiment Station, Experiment, Ga	45	1		46
Hatch Experiment Station, Amherst, Mass	13			13
Idaho Experiment Station, Moscow, Idaho	6	50	36	92
Illinois Experiment Station, Urbana, Ill	5			5
Iowa Experiment Station, Ames, Iowa	135		11	146
Kansas Experiment Station, Manhattan, Kans	140			140
Louisiana Experiment Station, Calhoun, La		1		1
Maryland Experiment Station, College Park, Md	7			7
Michigan Experiment Station, Lansing, Mich	63			63
Minnesota Experiment Station, St. Anthony Park, Minn	67			67
Minnesota sub-Experiment Station, Crookston, Minn	2			2
Missouri Experiment Station Columbia, Mo		3		3
Montana Experiment Station, Bozeman, Mont	72	22		94
Nebraska Experiment Station, Lincoln, Nebr	132			132
Nevada Experiment Station, Reno, Nev	5			5
New Mexico Experiment Station, Mesilla Park N. Mex			51	51
New York Experiment Station, Geneva, N. Y	8			8
North Dakota Experiment Station, Fargo, N. Dak	79			79
Ohio Experiment Station, Wooster, Ohio	114			114
Oklahoma Experiment Station, Stillwater, Okla	71			71
Oregon Experiment Station, Corvallis, Ore	140			140
Rhode Island Experiment Station, Kingston, R. I	5			5
South Dakota Experiment Station, Brookings, S. Dak	141	11		152
Tennessee Experiment Station, Knoxville, Tenn	74	45		119
Texas Experiment Station, College Station, Tex	115			115
Utah Experiment Station, Logan, Utah	79		5	84
Washington Experiment Station, Pullman, Wash	128		1	129
Wisconsin Experiment Station, Madison, Wis	7			7
Wyoming Experiment Station, Laramie, Wyo	135		133	268
Cornell University, Botanical Department, Ithaca, N. Y	122	9	114	245
New York Botanical Gardens, New York City	84			84
Washington-Lee University, Lexington, Va		38	109	147
Total	2,281	184	462	2,927

SEED DISTRIBUTION TO FOREIGN COUNTRIES.

A large number of packages of grass and forage-plant seeds have been distributed by the Division to foreign countries, from many of which we have received in return seeds of promising varieties for cultivation in this country.

By examining Table No. III it will be seen that 1,110 packages have been distributed during the last three years. Many requests are received for seed for purely botanical purposes, so that only small packages have been sent out. In 1897, 122 varieties of grass and forage-plant seeds were sent to Prof. D. McAlpine, the government vegetable pathologist for the Department of Agriculture, at Victoria, New South Wales, the object being to test their growth under different conditions of soil, climate, and moisture, but mainly to prove their drought-resisting properties. Twenty-one of these grasses resisted drought, and of these seven were very conspicuous for their fresh green growth. Among the forage plants other than the grasses, two were found to be suitable to Australian conditions and very resistant to drought. These were hairy vetch and a variety of the much-branched knotweed (*Polygonum ramosissimum*). Of the wheat grasses tested, bearded wheat grass, slender wheat grass, Western wheat grass, and false couch grass were found to resist drought well and to form a close, dense, grassy, succulent sward, especially the two last-named species. Among the lyme grasses 5 species were tested and 3 found to be highly drought resisting, viz, Canada lyme grass, giant lyme grass, and Virginia lyme grass. Eleven different fescues were tried, and only two, reed fescue and tall meadow fescue, proved to be of value, the latter forming a dense, succulent, grassy sward. Of the panic grasses 5 varieties were tested and 3 germinated, viz, the barnyard millet, deccan grass, and switch grass. The barnyard millet did remarkably well and produced a succulent growth 3 feet high. Out of the 16 forage plants not belonging to the true grasses only 3 germinated, viz, Dakota vetch (*Hosackia purshiana*), much-branched knotweed (*Polygonum ramosissimum*), and hairy vetch (*Vicia villosa*). The Dakota vetch produced a poor and straggling growth. The knotweed grew freely, branching and spreading, and attaining a height of 4½ feet. It withstood the drought well, but after the leaves fell off it became rather woody. Horses were very fond of the foliage. The hairy vetch grew luxuriantly and freely. It germinated in 20 days and rapidly formed a tangled mass of vegetative growth. It has been reported as a weed from some parts of Victoria; however there is little doubt but that it will prove to be an excellent soiling crop and green manure in Australia as well as here.

Dr. P. MacOwan, the government botanist for Cape Colony, also received 123 packages of grass and forage-plant seeds from this Division in 1897. Out of these the grama grasses and buffalo grass have proved to be of some value, and among the forage plants other than the grasses the velvet bean and Metcalfe bean are promising varieties, the former now being widely distributed by the Government at about 80 cents per pound.

Five pounds of seed of velvet bean were sent to the department of agriculture of New Zealand, and it is now being widely distributed in that country. It thrives well in the vicinity of Brisbane, Queensland. and is commonly regarded as a valuable addition to the forage plants of northern New Zealand. Favorable reports have also been received from Prof. J. F. Duthie, of Saharanpoor, Northwest Province, India, in regard to the introduction of the Metcalfe bean.

Table III.—*Number of packages of grass and forage plant seeds distributed to foreign countries.*

Country.	Fiscal year.			Total.
	1896–97.	1897–98.	1898–99.	
Africa:				
Capetown, Cape Colony, Dr. P. MacOwan	121	1	1	123
Mustappa, Algeria, Prof. L. Trabut	1	....	....	1
Durban, Natal, Prof. J. Medley Wood	122	....	....	122
Tunis, Algeria, l'Directeur de l'Agriculture et du commerce	....	....	6	6
Argentine Republic:				
La Plata, Dr. Antonia, general director of the department of agricultural chemistry	....	20	....	20
Australia:				
Adelaide, Hon. A. Molineux, secretary of agriculture	122	....	....	122
Melbourne, Prof. D. McAlpine, department of agriculture	122	....	....	122
North Queensland, Town Hall, Charles Towers and Henry O. Walkers	2	....	....	2
Victoria, Ruffy Post-office, J. H. Noiya	6	....	....	6
Canada:				
Ottawa, experiment station, Prof. J. Fletcher	135	....	....	135
Toronto, King street, East, J. A. Simmers	....	....	3	3
Central America:				
Honduras, Dr. R. Fritzgartner, director of mint	6	....	....	6
England:				
Royal Botanical Gardens, Kew	112	....	....	112
Cirencester, Frank McClellan	....	....	20	20
Oxford, 80 Woodstock road, Prof. R. B. Townsend	....	3	....	3
Egypt:				
Ghezeh, School of Agriculture, Prof. W. C. Mackenzie, director	....	....	6	6
France:				
Limoges, M. Ch. Le Gendre	....	4	....	4
Holland:				
Middleburg, M. Buysman	....	....	42	42
India:				
Saharanpoor, Northwest Province, Prof. J. F. Duthie	121	1	....	122
Madeira:				
Funchal, J. B. Blandy	....	1	1	2
Mexico:				
Santa Cruz, J. Lawton Taylor	....	6	....	6
Samoa:				
Apia, Hon. William Churchhill, United States consul-general	6	....	....	6
Switzerland:				
Zurich, director seed-control station	119	....	....	119
Total	995	36	79	1,110

REPORTS RECEIVED FROM VOLUNTEER EXPERIMENTERS.

The cooperation which the Division has received from farmers in all parts of the country is very gratifying. It proves that they are alive to their own interests and are anxious to become familiar with newly tried or recently introduced grasses and forage plants that are likely to prove of considerable value under cultivation. By examination of the table on page 11, it will be seen that a total of 1,713 reports has been received in answer to 5,120 packages of seed sent out. This large difference is mainly due to the fact that when the seed was first distributed in 1896–97 no report blanks were sent or requests made for a report as to the results of the experiments, and, in some cases in later years, by neglect on the part of the experimenter to take notes on the plants during their growth. In consequence of this they had not the necessary knowledge to fill out the blanks forwarded them and so neglected sending in a report of any kind.

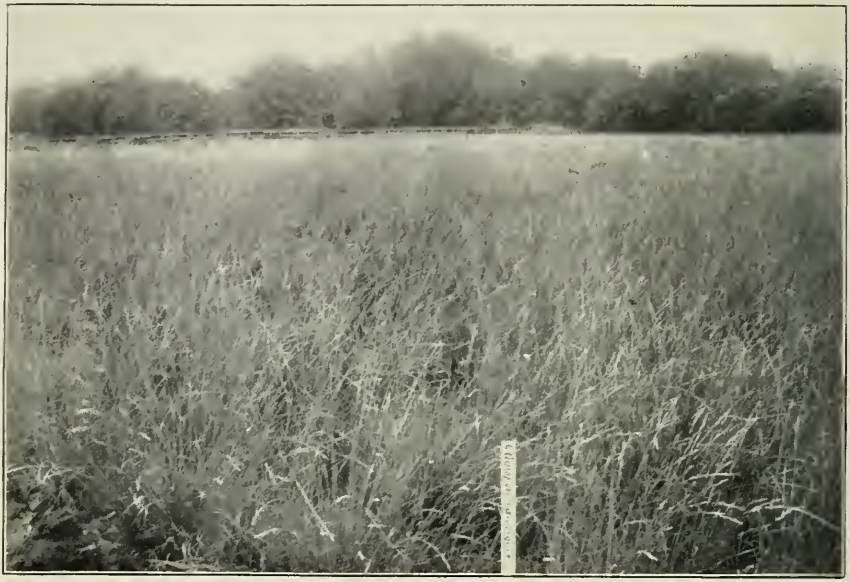

FIG. 1.—BUNCH WHEAT GRASS (AGROPYRON DIVERGENS), U. S. GRASS STATION AT WALLA WALLA, WASH.

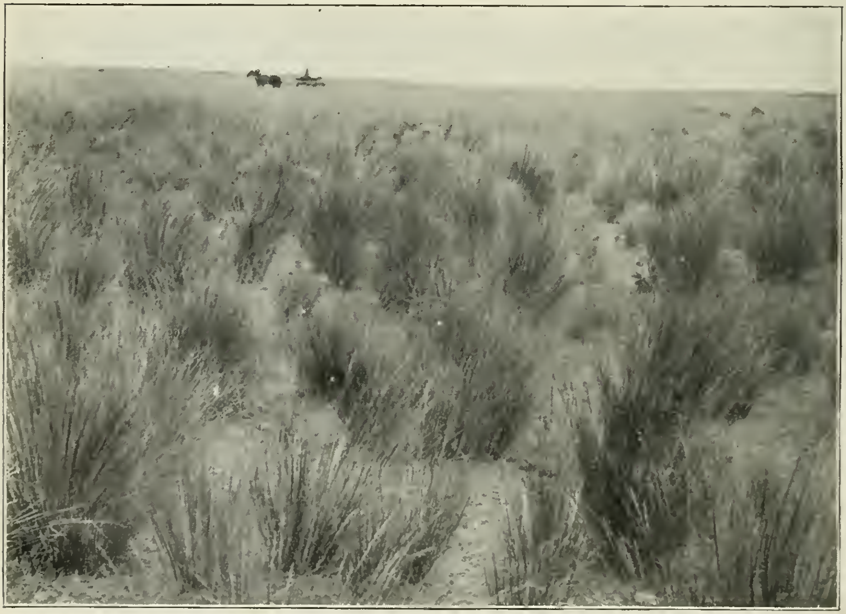

FIG. 2.—BUNCH WHEAT GRASS (NATURAL GROWTH), OREGON.

From a photograph by A. B. Leckenby.

During the years 1898 and 1899 blanks for reports were sent to all those receiving seed from this Division for trial, containing the following questions:

(1) Kind, conditions, and preparation of soil?
(2) Date and method of planting?
(3) Cultivation, if any?
(4) Date of harvesting and stage of maturity reached when harvested?
(5) Date of ripening?
(6) Yield per acre (if practicable)?
(7) Quality of product?
(8) Notes on growth, probable, value, etc.?

It will be noticed that there are many varieties in the table which have been reported on and yet are not included in this report, there being 251 varieties sent out and only 40 discussed. The reason for this is that the economic value of the others has not been sufficiently demonstrated to warrant a report on them at this time. The number of reports is given in the table on page 11, under the following divisions: Excellent, 101; good, 607; unsatisfactory, 287; failures, 718.

The largest number of reports have been received on the following varieties: Smooth brome-grass, 284; hairy vetch, 206; red lump millet, 166; red clover, 152; alfalfa, 148; and meadow fescue, 101.

VARIETIES OF SEED EXPERIMENTED WITH AND TESTIMONY OF EXPERIMENTERS.

BUNCH WHEAT GRASS (Agropyron divergens).

(Plate I, figs. 1 and 2.)

A slender, usually densely tufted native grass, 1 to 2 feet or more high, with very narrow spreading leaves and usually bearded spikes. This grass is common in the Rocky Mountain and Pacific Slope regions, extending westward to the coast. When grown upon good soil it possesses much agricultural value and is considered by ranchmen as a good grass for winter grazing. As it will thrive in the semiarid regions of the Northwest, its cultivation should be carried on more extensively. Seeds of this variety were sent to 11 experimenters, but no reports have yet been received.

Our special agent at Walla Walla, Wash., from the results of experiments carried on at the station, considers it one of the best grasses for reclaiming the worn-out ranges, as it thrives under conditions of extreme drought and affords excellent pasturage for all kinds of stock.

WESTERN WHEAT GRASS (Agropyron spicatum).

A rigid, upright, perennial, native grass, 1½ to 2½ feet high, with foliage, spikes, and rootstocks closely resembling the common couch grass of the Eastern States. The whole plant differs, however, from the quack grass in having a bluish color, and on this account has received the name "blue stem." This grass is quite distinct from the blue-stem grasses of Nebraska and other Western States, which are *Andropogons.* In its native state western wheat grass is found growing on bench lands and river bottoms. It grows luxuriantly all over central Texas and withstands the droughts to which that section of the country is periodically subjected. While it will not produce as much hay to the acre as some other species, stockmen value it highly for its nutritive qualities. In Montana and the neighboring States it furnishes a considerable amount of native hay and pasturage, and is there regarded as one of the most important forage plants. This grass would make excellent hay, and should be introduced into cultivation.

Thirty experimenters were supplied with seed of western wheat grass by this Division in the spring of 1899, but only 5 have reported, with 1 satisfactory result. The large number of failures is probably due to lack of knowledge of the best time and method of sowing the seed of this grass.

Mr. George T. McWhorter, Riverton, Colbert County, Ala., writes:

> The seed was sown broadcast on a deep, smooth bed on March 1, 1899. It germinated and grew moderately well, then died down during the drought, but revived again after the light fall rains. So far it is a promising variety.

SLENDER WHEAT GRASS (Agropyron tenerum).

A valuable native perennial grass about 3 to 4 feet high, with numerous soft leaves and a long, slender, erect spike. It is found growing wild in dry soil from New Mexico and southern California to Washington and British Columbia and eastward to New Hampshire and Labrador. It responds readily to cultivation and produces excellent results when slightly irrigated. When well grown it forms a close, uniform growth that yields as much per acre as an average field of timothy. Considering its high nutritive value no more profitable grass can be found for dry regions, especially on saline soils. It is one of the most valuable grasses for the Rocky Mountain region. During the years 1898 and 1899, 89 three-pound packages of the seed of slender wheat grass were distributed. This distribution includes experimenters in 12 different States. Twenty-eight reports have been received from 10 different States, very favorable ones having been received from Colorado, Idaho, Montana, and South Dakota.

The following reports will indicate its value in some sections of the country:

Mr. Marion Flaherty, Bozeman, Gallatin County, Mont.:

> The slender wheat grass made a good growth, at least 2 feet high. Stock eat it as well as clover or timothy. I think wheat grass will make a valuable feed for young stock. I want to try it on a larger scale next year.

Mr. Ellis M. Cameron, Post Falls, Kootenai County, Idaho:

The seed was received very late and did not have a fair chance, but it came up evenly and maintained a strong, vigorous growth all through the extremely hot weather until destroyed by grasshoppers. It is the most vigorous grass I have ever tested in this country and is a very valuable forage plant.

Mr. W. H. H. Phillips, Brookings, Brookings County, S. Dak.:

I am very much pleased with this grass. I judge that it would produce at least 2 tons of hay per acre. It crowded out every weed and other grass, and even took a good hold on a small piece of sod. We need such a grass for our weedy pastures.

RHODE ISLAND BENT GRASS (Agrostis canina.)[1]

This species of bent grass was introduced from Europe, and is now cultivated to some extent in the Eastern States for lawns, golf links, tennis courts, polo grounds, and occasionally for permanent meadows and pastures. In beauty and texture it is surpassed only by the creeping bent. The seed may be sown from the middle of April to the middle of May, or from the middle of August to the middle of September. If sown in the spring, it should be done as early as the land is in suitable condition, in order that the young plants may become sufficiently well established to withstand the often dry and hot summer months. The seed should be scattered evenly over the surface, and not covered by more than one-eighth of an inch of earth.

Since 1896 seed of this variety has been sent to forty-six experimenters, eight of whom have sent in reports, and only one of these is favorable. Most of the others failed to get the seed to germinate satisfactorily. These failures are in some instances due to requests for seed to be sown in parts of the South and Southwest, where it would be almost impossible without the greatest care to get a stand of this grass. In others they are due to the small quantity of seed (1 quart) sent out, and the difficulty in recognizing the young plants, which are very small. When seeding down a lawn, a liberal quantity should always be used. As a rule, about 1½ pounds to 100 square yards or 3 to 4 bushels per acre is sufficient, poor land requiring more seed than fertile land.

The following report has been received:

Mr. James Hines, Anaconda, Teller County, Colo.:

A good, black, well-prepared sandy loam was used. The seed was sown about the middle of June. It is doing nicely, and has not winterkilled.

CREEPING BENT (Agrostis stolonifera).[1]

A fine-leafed, hardy, native, perennial grass with long, prostrate, or creeping stems, which spread very rapidly and form an excellent velvety turf for lawns. In texture it far surpasses any of the other lawn grasses. The color of the lawn produced by it is somewhat lighter than Kentucky blue grass; but if this be regarded as a fault, it is fully counterbalanced by its superior turf-forming habit. When a lawn is desired within a short space of time and a small portion of turf is accessible, it may be carefully cut and divided into pieces 2 or 3 inches square, and transplanted about 6 to 8 inches apart. If the soil has been properly prepared, the grass will spread entirely over the whole surface in less than three months, and make a more certain and satisfactory lawn than can be obtained by seeding.

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[1] See "Lawns and Lawn Making," by F. Lamson-Scribner, in Yearbook of Department of Agriculture for 1897, p. 355.

When seed is used, it may be sown from the middle of March to the middle of April, when it will produce an excellent turf by September, providing the soil has been well prepared. Seed may also be sown in the fall, but it must be done early enough to secure a good strong growth before winter sets in. Twenty pounds of seed per 100 feet square or 3 bushels per acre is recommended for the best results. In the far South and Southwest, creeping bent can not be successfully grown.

Thirty-four experimenters have been supplied with trial packages by this Division since 1896, 9 of whom have complied with the request for a report. In 3 cases the seed germinated well, but was killed out by long-protracted drought, while in the other cases the seed failed to germinate.

"M. B." SORGHUM (Andropogon sorghum vulgaris).[1]

This variety of sorghum was originated by Miss Mary Best, of Medicine Lodge, Kans.; hence the name "M. B." Sorghum. A considerable quantity of seed was sent by her to the Department, and a portion of it was distributed by this Division as follows: To 3 experimenters in Florida, 6 in Georgia, 2 in Mississippi, 2 in Nebraska, 2 in South Dakota, 1 in Texas, and 1 in Virginia. Eleven out of the 17 receiving the seed sent in reports, of which the following are representative:

Mr. Philip D. Cory, Keller, Bryan County, Ga.:

> This plant impresses me favorably. It is earlier than Orange and is a more vigorous grower. I regret that circumstances have prevented me from making a sirup test. Our stock—horses, cattle, hogs are unequivocal in their commendation of it as a forage plant.

Mr. A. T. George, Cuthbert, Randolph County, Ga.:

> It is very fine; nothing better. As it grows very quickly, its value cannot be excelled. There is nothing better either to feed green or to cure and feed dry. It makes more forage to the acre than anything else we sow, and is excellent for all kinds of stock.

Mr. J. L. Stevens, Waldo, Alachua County, Fla.:

> I think it is a good forage plant for Florida. It did very well, even though it was planted late in the season.

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[1] For discussion of "Sorghum as a forage crop," see Farmers' Bulletin No. 50, U. S. Department of Agriculture. (Agros. 13.)

JOHNSON GRASS IN GRASS GARDEN ON GROUNDS OF UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D C.

Hon. H. C. Warner, Forestburg, Sanborn County, S. Dak.:

> This variety was grown in comparison with amber cane, and had greater leafage and suckers. It was dried in the shock and then fed to milch cows, which ate the leaves and heads readily, but would not eat the stalks. It is not, however, as profitable as corn for this section.

JOHNSON GRASS (Andropogon halepensis).

(Plate II.)

A stout perennial with smooth, erect stems, 3 to 8 feet or more high, and strong, creeping rootstocks. It is a native of southern Europe and the warmer parts of Asia and northern Africa. Its introduction into this country is said to have occurred as follows: In 1840 the Sultan of Turkey wrote to Governor Means of South Carolina asking that he send a competent man to teach his subjects how to raise cotton. A Colonel Davis was sent, and upon his return he brought back many valuable seeds, among which was the seed of what was there called Sicily grass. In 1845 Mr. William Johnson, of Alabama, went to South Carolina, where he obtained some of this seed, which he brought home in his saddlebags and sowed in his plantation, where it still grows. From this farm much of the seed was obtained at that time; hence the name Johnson Grass. This grass has now become widely distributed and well known throughout the Southern States, where it is much valued for hay, if cut at the time of full bloom. Because of its rapid growth, it will give from 2 to 4 cuttings yearly, and each cutting will make from 1 to 2 tons of hay. The serious objections to its cultivation are the great difficulty of destroying it when the land is required for other purposes, and the ease with which it spreads to fields where it is not wanted.

Mr. Herbert Post, formerly of Alabama, now of Fort Worth, Tex., gives the following method of eradication:

> Don't expect to get rid of this grass by spring or summer cultivation. It can not be done. In the month of August the summer growth has about ceased. With a strong team and a 2-horse plow break up the ground to the depth of 6 inches, leaving the furrows as high and rough as possible. The action of the elements mellows the soil and all exposed roots die. In two or three weeks, with a straight-toothed harrow (not slanting), cross the furrows and draw the remaining roots to the surface, where they will soon die. Your hogs would delight to have them. When ready to put in fall grain, plow again across the furrows to the depth of 8 inches; harrow well, and sow wheat, barley, oats, or rye. Pasture during the winter and early summer, and cut the crop for hay or summer feed. On the stubble sow broadcast 2 bushels of cowpeas, and harrow them in. In early fall cut the vines for hay, or, what will be still better for the land, plow the vines under while still green. Now you are rid of the Johnson grass, and you can plant any crop you desire, as the roots of this grass, cut off 8 inches below the surface, will decay.

Very little seed of this grass has been distributed by the Division, as the farmers are very much prejudiced against it and are afraid to sow it. Those who have given it a trial, however, report it a great success, excellent reports having been received from Louisiana, Mississippi, and Texas. Many others, however, condemn it very strongly and look upon it as one of the most dangerous weeds. The following are some of the reports for and against the cultivation of this grass:

Mr. Herbert Post, Fort Worth, Tex.:

> My knowledge of this grass is obtained from the cultivation of it for twenty-five years, fifteen of which I grew it for hay in Alabama, where it came into competition with Northern hay and brought the same price. Even those who do not like it in their cultivated fields acknowledge its great value. Because of its rapid growth, it can be cut 3 and 4 times each season, and is earning more money than any hoed crops. Mr. N. B. Moore, a prominent farmer of Georgia, for forty years experimented with various grasses and finally chose this grass as the best of all, and it is still growing on his place near Augusta, the whole farm being given up to it from choice.

Prof. S. A. Hoover, Springfield, Greene County, Mo.:

> I look upon it as the most dangerous weed that can enter the State. I believe when it once gets a foothold on a farm it is utterly impossible to get rid of it. It spreads by means of its rootstocks as well as by its seeds. Plowing only helps it to spread by breaking up these rootstocks and scattering the pieces. It is simply impossible to grow any crop with Johnson grass. The immense number and size of its rootstocks prevent the growth or cultivation of other plants with this pest. Hogs will eat the rootstocks, but there are always enough pieces left to start another crop. It grows entirely too coarse for hay in this part of the country. In western Texas, where the rainfall is light and other forage plants do not succeed, it is a good thing to raise for hay, as the land can be completely given up to it. In this State and in Kansas, where much better forage plants may be grown successfully, it seems very foolish to attempt its cultivation. In fact, farmers ought to be on the lookout to destroy every stalk that makes its appearance.

SMOOTH BROME GRASS (*Bromus inermis*).[1]

(Plate III.)

The seed of this variety was obtained by the Secretary of Agriculture for the Department through Prof. N. E. Hansen in February, 1898. The lot consisted of 12 tons from the Penza province, in the Volga River region of Russia. At the agricultural school at Uralsk, on the Ural River, where the annual rainfall is 12.6 inches, the smooth brome grass was regarded as the best grass for the steppes. Professor Hansen writes:

> The best Russian authorities do not think this grass equal to timothy in feeding value, but it flourishes in sections where timothy is an utter failure. Its chief value will probably be in dry regions.

Smooth brome grass is a vigorous, hardy perennial, with strong, creeping rootstocks, smooth, upright, leafy stems 1 to 4 feet high, and loose, open panicles or "seed heads" 4 to 8 inches long. In a few years it forms a very tough sod, soon crowding out other grasses, clovers, and weeds. Its remarkable drought-resisting qualities have

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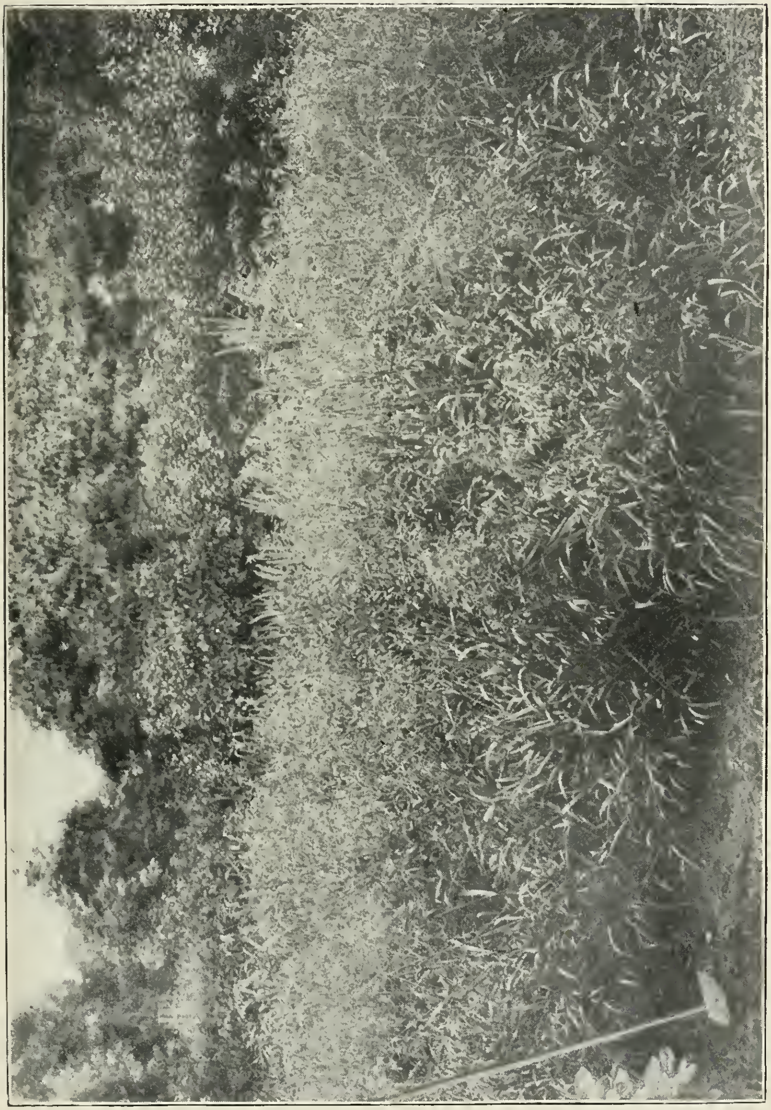
[1] For full discussions on smooth brome grass see Circular No. 18, Division of Agrostology, U. S. Dept. Agr.; Nebraska Experiment Station Bul. No. 61; South Dakota Experiment Station Bul. No. 45; North Dakota Experiment Station Bul. No. 40.

PLATE III.



SMOOTH BROME GRASS (BROMUS INERMIS), SHOWING PLAT OF THE GRASS GROWN IN THE UNITED STATES GRASS GARDEN, WASHINGTON, D. C.

From a photograph by F. Lamson-Scribner.

proved it to be a most valuable grass for dry regions where other grasses could hardly exist. It is the most suitable grass yet introduced for the dry regions of the West and Northwest. As it is thoroughly permanent and grows with wonderful rapidity, producing heavy crops of hay and luxuriant pasturage, its value to the farmers of the semiarid regions of this country can not be overestimated. All kinds of stock eat it with relish, and the chemical analyses made show that it is rich in flesh-forming materials, much more so than timothy. It is very hardy, and not injured by severe spring and fall frosts when once established. As it starts to grow very early in the spring, before any of the grasses upon the native prairies show any signs of life, and remains green and succulent far into November, it will supply the long-felt want of early and late fall pastures.

In the spring of 1898, 536 packages of the Russian seed of smooth brome grass were distributed by this Division through the Section of Seed and Plant Introduction. This does not include the State experiment stations, many of which received large consignments directly from the Department. The States receiving the largest amounts of seed were Kansas, Montana, Texas, Colorado, Nebraska, North Dakota, Washington, and Oregon, in the order named. Out of the 536 experimenters receiving the Russian seed of smooth brome grass, 284 have complied with a request from the Division for reports as to its success or failure. From the reports received it is evident that it is little influenced by the changes of climate. It does well in California, Colorado, Indiana, Iowa, Kansas, Montana, Nebraska, North Dakota, Ohio, Oregon, South Dakota, Tennessee, Utah, Washington, and Wyoming. Sufficient experiments have not been carried on in the South to enable us to state here its value for that part of the country. Professor Tracy, of Mississippi, speaks of it thus:

> Although its growth on the test plots was all that could be desired, its growth in the field has often been disappointing, and it is not gaining in general favor. * * * After eight years' experience with this grass, on a great variety of soils, it appears to be of doubtful value in the Gulf States. It has here some value for winter grazing on dry and loose soils, but its place can be better filled by other species.

The experiment stations of California, Colorado, Iowa, Kansas, Minnesota, Manitoba, Nebraska, and North and South Dakota have all made extensive experiments with smooth brome and recommend it highly both for hay and pasture, especially for dry and poor soils.

The following reports from volunteer experimenters in the different States prove conclusively the immense value of the smooth brome grass to the farmers of this country:

CALIFORNIA.

Messrs. Guill Brothers, Chico, Butte County:

> The seed was drilled in by hand on the 4th of March, 1898, and covered 2 inches deep. The soil is a sandy loam, and had been put into excellent condition by fall

plowing and harrowing with a spring-tooth harrow. The crop was cultivated three times. The vitality of this seed is remarkable; we had no rain to wet the ground for six months—from May to November—yet there was none of the grass that died from drought. The grass made a growth of about 8 inches during the season. During the autumn and early winter it has continued its development and is now in excellent condition.

A plot of this grass was sown broadcast on October 21 and harrowed in and is looking very well at the present time. It has withstood some of our severest winter weather without any ill effects. The food value has not yet been tested, but otherwise it is a remarkable grass.

Mr. P. H. Murphy, Perkins, Sacramento County:

A clay loam soil was used which had been plowed and harrowed. The seed was sown March 1, 1898, and then harrowed in. As the ground was dry, having no late rains, it did not come up. This year (1899) the land where the brome grass was planted in 1898 was flooded and there was a heavy crop. It grows about 3 feet high and looks like chess or cheat which grows in wheat, only the seed is finer. It makes a good hay for cows if cut when in full bloom, but I prefer oats or barley for hay.

COLORADO.

Mr. E. E. T. Hazen, Holyoke, Phillips County:

The seed was sown broadcast April 28, 1898, at the rate of 3 bushels per acre. The soil is a sandy loam of medium quality and fertility and was plowed 10 inches deep and harrowed twice before sowing and once after.

The seed was well up May 13, but when about 4 to 6 inches high Russian thistles appeared among them and in a short time completely overshadowed them. The brome grass then stopped growing in height and formed a perfect carpet-like mat on the ground, retaining its fresh green color until December 1. A few stalks, however, found their way up through the thistles and headed at the height of about 18 or 20 inches.

Mr. Melvin Thompson, Lansing, Arapahoe County:

The seed was sown broadcast on April 4, 1898, and covered by light harrowing. The soil is light, sandy, upland loam, and was plowed, planked, and harrowed until moist and in fine condition. The grass was kept down by "hoppers," but made a fair stand, and at present date, November 6, is in good condition.

Mr. W. W. Lindsay, Gulnare, Las Animas County:

The brome grass came up nicely, making a good stand, but owing to extreme drought, the worst in this section for twenty years, I am afraid most of it is killed. It may come up, however. I think in any ordinary season it would do well here, once it became established, as it starts to grow earlier than even alfalfa, which is our mainstay. It is said to do well in some parts of the State.

Mr. M. McFarland, Villagrove, Saguache County:

A sandy loam was used which had been in cultivation for several years. The seed was sown broadcast in May, 1898, and irrigated immediately after sowing. Shortly afterwards we had a heavy snowstorm. I did not get a good stand and did not harvest last year, as there was not enough growth. I harvested to-day (September 25, 1899), however, with binder to save seed. The yield per acre is probably 200 pounds, the seed being 100 per cent heavier and better than that sown. It withstands droughts remarkably, and is the earliest grass green in the spring and latest in the fall. It will furnish first-class pasturage after cutting for seed, and I think will be valuable to sow in permanent pasture land.

INDIANA.

Mr. Henry Wehry, North Vernon, Jennings County:

The seed was sown March 8, 1898, on ground that had been harrowed twice with a spring-tooth harrow and once with a spike harrow after sowing. The soil is a clay loam, which was sown to oats and Canada field peas in 1897, plowed in October, 1897, and then left to lie over winter in the rough furrow. The grass was damaged considerably by hard frost on April 6 and 7, but did not seem to suffer any from drought. It made about the same growth as orchard grass, but stood dry weather better. The growth was from 6 to 18 inches in height.

IOWA.

Mr. H. J. Giddings, Sabula, Jackson County:

The seed was sown broadcast April 1, 1898, part of it with oats and part without a nurse crop. The soil is a clay loam and was in good tilth, having been plowed and well harrowed. The grass was all up nicely on May 1. It has not produced a crop yet, but at present it covers the ground with a growth about 3 inches high. A very severe drought during the growing season killed nearly all of the timothy and clover sown in the spring; but the brome grass stood it better than either of them and is better on the oats stubble than where it was sown without a crop. All young clover and timothy were winterkilled, but the brome grass was not injured a particle. It commenced to grow very early this spring, and was green before anything else. As it produces a large amount of aftermath, it seems to me that it will be better for pasture than for hay, especially for waste places and land not easily cultivated.

Mr. E. L. Hayden, Oakville, Louisa County:

The seed was sown on clay loam about the 1st of April, 1898. It was cut for hay about the last of June when just out of bloom. The quality of the hay was good, but it will not take the place of timothy in this part of the country.

Mr. I. W. Hoffman, Roselle, Carroll County:

The seed was sown broadcast in May, 1898, on a sandy loam. This grass seems very promising for this part of the country. It possesses several good points, such as resisting drought and not winterkilling. It forms a thick, luxuriant growth and is very well liked by all kinds of stock. It is a strong grower, very dense and stocky, and seems to be valuable here for both hay and pasture.

Mr. S. H. Talley, Packwood, Jefferson County:

The seed was sown broadcast by hand April 11, 1898. The soil was a light clay loam which had been rolled and thoroughly disked. After sowing it was redisked and harrowed smooth. The brome grass was sown with clover and grew well, forming a good sod, and now, November 22, the brome has the field. The weeds were mowed off about July 20. I think it will prove good for pasture, and will stand much trampling.

Mr. J. H. Talley, Packwood, Jefferson County:

The quality of brome grass is good, but not quite equal to red clover. It makes an excellent growth, remaining green all winter where protected. It is a very gross feeder, making a very stiff sod, and a splendid grass for permanent pasture. I highly recommend it where it is too dry for timothy.

KANSAS.

Mr. A. T. Bentley, Wallace, Wallace County:

The seed was sown March 9, 1898, on a clay soil which had been plowed deep and thoroughly rolled. It made a good growth in spite of the grasshoppers, but not sufficient to harvest.

Mr. Clark Bell, Burlington, Coffey County:

The seed was sown broadcast April 25, 1898, on a limestone prairie. The land was plowed in September, 1897, harrowed, then dragged with a plank drag, and harrowed again after sowing. The seed came up in a few days, looked thrifty, and made a good stand; but, owing to the very wet spring and summer, the crab grass came so fast that it was necessary to mow the field, which retarded the growth of the brome grass. However, at this writing the brome grass looks well, and I am quite well satisfied with it. It starts very early in the spring and continues green until late in the fall. At this date—October 24, 1899—it is the only grass in the pasture that is green, and the stock eats it well.

Mr. Benj. Brown, Natoma, Osborne County:

The seed was sown broadcast April 10, 1898, on well-prepared, rich, prairie-bottom soil. I secured a fine, strong stand, but the most of it was killed by drought in the latter part of 1898. Most of that on the low land lived and made a strong growth in 1899. I think it may be a valuable grass, but not on the dry uplands. It seems to be better adapted here for pasture than hay. The leaves are large, dark green, and succulent. Stock is fond of it.

Mr. W. C. Hollewell, Barnes, Washington County :

A black loamy soil, plowed early, as soon as frost was well out of the ground, and harrowed thoroughly. The seed was sown broadcast on March 20, 1898, and covered by harrowing. The grass grew to be about 2 feet high, with an undergrowth of from 8 to 12 inches. It remains green until hard freezing. I think it is a grand success for this country.

Mr. George James, Concordia, Cloud County :

The seed was sown April 22, 1898, part with press drill and the remainder broadcast. All came up at the same time. The soil is black prairie, in a small flat hollow, but not low or wet. The dry weather set in about July 1 and lasted until September 9, when we had a rain that wet the ground 2 inches deep. The grass had seemed to be dried out, but it came up and is now 6 inches high, although the stand is not as good as when first started in spring. I cut one-fourth of an acre of it with a harvester and got 3 bushels of seed which is better than that received from you. I believe that it will make a good pasture. It gets ripe and dies down in July, but springs up again in September. If there is any moisture it will grow as quickly as clover. I intend sowing 3 acres for pasture on low ground next year, and I believe it will be all right where the ground will grow a good crop of clover.

Mr. S. P. Langley, Morland, Graham County :

The seed was sown broadcast about May 10, 1898, and lightly harrowed. The soil is a very moist, sandy loam, and had been plowed with a common stirring plow. The weeds were mown from among the grass about June 15. The grass grew very slowly, but formed a very compact sod. Frost had little effect on it, and it afforded good pasture.

Mr. M. Olson, Mullinville, Kiowa County:

The soil was a black sandy loam, which had been plowed and harrowed. The seed was drilled in about the middle of May with a press drill. It came up very well, but as it was wet in the spring the weeds got ahead of it. After this we had a dry spell which dried it out so that there was nothing left to harvest.

Mr. T. E. Pearce, Edgerton, Johnson County:

The land used was high prairie soil on the bluff of a creek, part of which is underlaid closely with rock. The soil was deeply plowed, disked, and harrowed down fine. The seed was sown broadcast on April 19, 1898, and then harrowed in lightly, the ground being in a very moist condition. I thought it had died out in the fall, and so reported to you, because wild grass had completely covered it up. In the spring of 1899, however, it awoke like a sleeping giant and covered the ground with dense foliage, 1 foot high. It did not produce much seed, but proved to be an excellent pasture grass. The grass does not get tough, like most grasses do, and is very tender to eat. The green growth starts very early in the spring, and I think, from what I have seen of it so far, that it will be a fine pasture and hay grass.

Mr. George Strickland, Russell Springs, Logan County:

The seed was sown broadcast on April 1, 1898, on one acre of land. It came up nicely, but not quite as thick as I would have liked. This spring it has started, and looks very well, although the grasshoppers were very destructive to it in the fall.

MARYLAND.

Mr. John C. Bartlett, Easton, Talbot County:

The seed was sown by hand in April, 1898, on a clay loam that had been prepared by being plowed, harrowed, and rolled. The seed, after being sown, was rolled in. The ground had been manured in the fall with stable manure. The grass came up well and now looks about like lawn grass.

Mr. John C. Talbot, Easton, Talbot County:

The seed was sown broadcast in April, on good, well-prepared clay loam, in an apple orchard which is used as hog pasture. It looks now about like orchard grass, but does not stool or go to seed. It went through last winter all right.

MICHIGAN.

Mr. H. W. Crawford, Sitka, Newaygo County:

A clay loam prepared as for potatoes, and sown with the brome seed about June 10, 1898. Solid stools of roots were produced from 4 to 6 inches across. It has wintered all right, and I shall watch its growth with interest. I think that it will make a good pasture grass, and is worthy of a thorough test.

MINNESOTA.

Mr. S. M. Warman, Sandstone, Pine County:

The seed was drilled in May 16, 1898, in sandy upland soil. The grass ripened in September, after surpassing all imagination. The quality of the product was perfect. It is splendid grass for us, the hay being worth about $7 per ton.

MONTANA.

Mr. E. Beach, Augusta, Lewis and Clarke County:

A dry, gravelly, bench land was used. The seed was sown broadcast on May 5, 1898. The grass was cut for hay about July 20. The quality of the product was good, yielding about 1 ton per acre; and if it continues as at present, it will be a very good grass for dry climates, both for pasture and for hay. It seems to contain more nutriment for stock than alfalfa or esparcette, and they eat it more readily.

Mr. William Flannery, Bozeman, Gallatin County:

A sandy loam, excellent for almost any kind of crop, which had been well cultivated by plow, disk, and harrow, was used. The seed was sown June 17, 1899, partly in drills and partly broadcast, then harrowed and rolled. The crop was irrigated twice. The grass came up, and is now in a thriving condition. As it was planted late and is a perennial, I shall not be able to form an opinion of its value until it has wintered and grown another year.

William W. Gamble & Son, Choteau, Teton County:

A gravelly, bench-land loam, which had been irrigated, well plowed, and harrowed, was used. The seed was sown May 19, 1898. The quality of the product is good. The grass starts early in spring and grows rapidly and continuously through all sorts of weather—warm or cold, wet or dry—without apparently being much affected by climatic conditions until maturity. With us it did not make much of a fall growth. Its probable value is considerable, although just how much we have not seen enough of the plant to determine to our satisfaction.

Mr. Paris Gibson, Great Falls, Cascade County:

The seed should be sown in April on well-pulverized soil, and much care should be used in brushing or harrowing it in. Ordinary preparation of soil is required. While it will thrive better on rich soil, it makes a remarkable growth on sterile lands. My field has produced large crops for three years with no cultivation. To make good, tender hay in Montana it should be harvested in June, or as soon as it heads. It is in full bloom by the middle of June. If ground is properly seeded it will yield from 2 to 2½ tons per acre. I believe it will be a most valuable hay crop for Montana, as it is a persistent grower, comes up very early in the spring, and does not kill out easily. I think two crops can be gathered in most seasons.

Mr. W. H. Heidman, Kalispell, Flat Head County:

The grass was sown broadcast April 23, 1897, 1 pound of seed to one-fourth of an acre. The soil, a sandy loam, had been sown in oats the previous year and was harrowed before sowing, and harrowed lightly and rolled after sowing. About the 10th of July the crop was cut, as the weeds were very bad. The grass made a good growth and was in bloom June 28, 1898, ripening August 1. If cut for hay, it would make about 1 ton to the acre. This grass is eaten greedily by the horses; cattle and hogs like it. The seed germinates as quickly as oats. It came out green this spring and commenced to grow while it was yet quite cold, making good pasturage long before any other grass started. We have had no rain since the middle of June, but it keeps green, and looks fresh and healthy.

Mr. Len. Lewis, Lewis, Meagher County:

A limestone soil on dry, bench land was used. The crop was well irrigated. I secured a heavy yield. The grass grew rapidly and produced a very luxuriant growth. I think it will be a very valuable grass. I sowed 7 acres more this year and expect to put in about 50 acres next year.

Mr. T. P. McDonald, Red Lodge, Carbon County:

The seed was sown on June 14, 1898, on plowed sod that had been disked 4 times. After sowing the ground was harrowed both ways. The upper end of the piece was irrigated once. I find it to be a strong grower and believe it to be a fine pasture grass. I think it is adapted to a dry climate. It was green until winter. It proved to be the best pasture grass we have found for dry lands and did better where it was not irrigated at an elevation of 5,800 feet.

Mr. Emory Vine, Miles City, Custer County:

The seed should be sown about March 26; then harrowed and irrigated after sowing. The soil, a gumbo clay loam, was plowed and harrowed in the usual way before seeding. When used for hay it should be harvested about 20th to 25th of June and for seed about 1st of August. It blooms about the 20th to 25th of June and ripens about August 1. The quality of product is good, and stock eat it readily. There is much to be learned about this grass. It will surely make a crop with less moisture than any other grass.

Mr. C. H. Williams, Deer Lodge, Deer Lodge County:

A sandy soil of granite formation was plowed 4 inches deep. The seed was sown broadcast on May 15, 1898, and covered lightly with a harrow and irrigated once. It is good for pasture and succeeds well on dry soil. It will probably be useful to reclaim ranges, but the yield is too light to be profitable for hay.

Mr. C. C. Willis, Plains, Missoula County:

The seed was sown May 4, 1898, on land plowed April 15, and harrowed fine. After sowing the land was thoroughly harrowed and rolled. The soil, which was a sandy loam underlaid with clay, had formerly been planted with bunch grass. Seeds formed in the heads about August 1 and ripened August 15. The yield is about 1½ tons per acre. The grass will do well on our bench lands if properly put in. It seems to stand dry weather well and grew from 18 inches to 2 feet high.

NEBRASKA.

Mr. H. S. Chapman, Pawnee City, Pawnee County:

A rich black loam was plowed and pulverized and sown with a drill on May 20, 1898. A thick mat of grass blades appear very early in the spring. It is a good pasture grass, but worthless for hay, as it is a low blady grass. It throws out a slender seed stalk about 14 inches high and produces an abundance of seed.

Mr. W. S. Delano, Lee Park, Custer County:

The seed was sown broadcast on May 14, 1898, and covered by light harrowing. One-third of the seed was sown with barley. The ground had been plowed in spring and cultivated with a harrow. The field was clipped with a mower except where sown with barley. The grass planted in barley was almost a total failure. It made a very good stand where sown alone, but the growth was light on account of drought. The brome-grass was pastured in spring of 1899, and then later a crop of hay was mowed July 10. After this cutting it top dried and died down. In October it started again from the crown, and at this date (October 31) it is 3 inches high. It is an excellent pasture grass, starting earlier in the spring than alfalfa, and thickens into a solid turf. All stock like it, and it promises to be an excellent grass for this section.

Mr. C. H. Searle, Edgar, Clay County:

The seed was sown broadcast about the end of April, 1898, on well-prepared black, loamy soil. The weather was very dry in July and August, and I was afraid that the grass was dead. However, it came out all right this spring very early, but did not make a heavy growth.

Mr. A. Shirley, Weeping Water, Cass County:

The grass was sown broadcast May 1, 1898, on black loam bottom land that had been plowed and harrowed till smooth. The tops of the weeds were clipped May 20. When harvested September 20 the grass was 18 inches high. About 1½ tons of hay per acre are produced of extra good quality. I consider it one of the best grasses for hay and pasture ever introduced into this neighborhood. It stands drought well.

Mr. J. W. Williams, Weeping Water, Cass County:

The seed was sown broadcast April 5, 1898, shortly after a rain and well harrowed in. The soil, a black loam, part well drained and part very low and wet, had been plowed 6 to 8 inches deep and well harrowed before sowing. On June 20 the weeds were taken off with mower. The grass made a very good growth and will be, I think, a good pasture grass.

NEW MEXICO.

Mr. James B. Horn, Cliff, Grant County:

The seed was sown broadcast on a gravelly soil June 1, 1899, and harrowed in. It does very well in low places and makes good pasturage or hay.

Mr. James K. Metcalfe, Silver City, Grant County:

The seed was sown broadcast on a high gravelly ridge early in May, 1898, and irrigated. It grew this and last summer, but only an occasional seed stalk was sent up. It looks as if it would be a very good pasture grass, but very thin, a few bunches seeding here and there at a time.

NORTH CAROLINA.

Mr. P. S. Early, Mocksville, Davie County:

A black loamy soil was used. The seed was sown May 10, 1899, and harrowed in. Just as the seed began to come up a hard frost came. I was very highly pleased with the start the grass made, and I believe had no frost come the result would have been fine. The land was moist and very rich.

Mr. J. S. Holmes, Bowmans Bluff, Henderson County:

A fairly good upland clay loam was used, which had been plowed with a one-horse plow and harrowed twice with a Thomas smoothing harrow. I sowed one acre at the rate of 31 pounds per acre on May 12, 1899, and covered once with a smoothing harrow. There was a fairly good stand, though hardly as good as some orchard grass higher up on the hill. The ground was badly washed by a heavy storm, but it looks now as if it would stand the winter all right.

NORTH DAKOTA.

Mr. Wm. Brittin, Sterling, Burleigh County:

A sandy soil was plowed and harrowed twice. The ground was well pulverized, but it was too dry for seed to germinate readily. The seed was sown broadcast May 12, 1899, at the rate of 2 bushels per acre. The grass made a good growth, but did not send up any seed stems. It rained May 17 and 21. The seed came up May 24, and held its own through a very dry season, and is still green November 1. I think it will succeed in this part of the country.

Mr. F. A. Eaton, Medora, Billings County:

A sandy soil was plowed and harrowed well and the seed sown broadcast on May 20, 1898. We think this will be a good grass for us, and next year will put in a large field of it.

Mr. N. S. French, Grand Rapids, La Moure County:

An upland prairie, that has been under cultivation about nine years, was plowed about May 4, 1898, and harrowed into good condition. The seed was sown with barley at the rate of about 70 pounds of barley and about 9 pounds grass seed per acre. I cut the barley about August 3, 1898. The brome seed was cut with a header about July 10, 1899. It is first class in all respects. Its growth and feeding qualities are such as will make it of incalculable value to this locality and climate. I have raised and cut forage crops for nearly forty years in 4 or 5 States, and I have never seen anything that seems to promise as much for any locality as this does for the Northwest. It is excellent for pasturage, so far as I can judge at this time.

Mr. W. Hanson, Englevale, Ransom County:

The seed was sown broadcast May 20, 1898, on clay loam that was plowed last fall. One-half was harrowed last fall and all was well harrowed this spring, making a very fine seed bed. The weeds were kept mowed down on three-fourths of the plot; the rest was sown with oats. I have a fine catch that bids fair to make a good growth next year. It is very green this fall, while all other grasses are dead and dry.

Mr. J. W. Higgs, Silver Leaf, Dickey County:

The seed was sown about April 18, 1898, on an upland field that had been in potatoes the season before and was in fine shape for grass. It made a good stand, but dry weather in July killed a good portion of it. This season, 1899, it was very thin, so I let it go to seed, then mowed it and left it on the ground. I think it will be thick enough next year. We have much trouble in this section to get a good stand. This is a fine grass, and I think it would yield enormously if one could secure a good stand. It grows about 3 feet high and is about the same as the brome grasses we have been growing here, which I think is our main grass. I want to put in 200 acres as soon as I can.

Mr. Chas. Kunth, Hebron, Morton County:

I gave out the seed in 1898 to about a dozen farmers, who planted it in different soils, and in every case it has been a success. Farmers have bought seed and planted many acres to it. Brome grass is considered the future forage plant in this section.

Col. W. W. McIlvain, Lisbon, Ransom County:

The soil was plowed 7 inches deep and subpacked. The seed was sown April 15, 1899, with wheat, or rather, on same ground after the wheat had been sown. The wheat was harvested the last of July, and there was a good undergrowth of grass 4 to 6 inches high. I have grown this grass on the grounds of the Soldiers' Home for three years very successfully, cutting two crops, one on June 1 and another September 1.

Mr. H. S. Nichols, Oakes, Dickey County:

A black sandy loam was plowed deep and manured. The seed was sown broadcast about April 15, 1898, without a nurse crop. The growth was thrifty and I should estimate the yield at 2 tons per acre had it been cut for hay. I am well pleased with it and believe that it is a very valuable grass. It seems to be a decided success in this locality, as it makes a good firm sod and starts earlier in the spring by two weeks than any other vegetation.

Mr. J. B. Power, Power, Richland County:

The seed was sown by hand about May 10, 1898, on poor sandy soil, which had been in wheat the year before. Nothing whatever shows now (October 19), but as this is said to be the normal condition of brome grass the first year, it will undoubtedly show up well next spring. We had similar results four years ago, but plowed up the land in the fall after seeing no growth, but have since had good growth along the edge of the same field. I believe it to be an excellent grass.

Mr. B. S. Russell, Jamestown, Stutsman County:

A black sandy loam was used, which had been prepared for cereals. Part of the seed was sown with oats as a nurse crop from April 15 to August 1, 1898. Where sown with a nurse crop it did not grow until the nurse crop was harvested, then it grew well. It yields about 2 to 2½ tons per acre. In quality it is very good where pastured, cattle going long distances to find it. It is well established as the grass for North Dakota. It takes kindly to the soil and is the earliest grass in the spring, even earlier than the bunch or buffalo grass, and is green in the autumn when the wild prairie grass is brown. It has been sown by many farmers this year in small parcels from 5 to 40 pounds, and will be increased by all next year.

OHIO.

Mr. J. E. Wing, Mechanicsburg, Champaign County:

A white-oak clay soil was slightly manured, plowed, and well prepared. The seed was sown with alfalfa May 20, 1898. It looks very thrifty and promising, with a dense leafy undergrowth. I expect it to be of great value to use with alfalfa.

OREGON.

Capt. Joseph Dawson, Bay City, Tillamook County:

A black sandy loam was well manured, plowed 6 inches deep, and rough harrowed once. The seed was sown May 4, 1898, by first sowing oats, harrowing once and then sowing the brome grass broadcast on the same ground. The land was then cross-harrowed and the ground smoothed with a clod-masher, and let alone to grow till harvest time. On August 20, 1898, I secured a heavy crop of grass. It matured as much as the seedsmen claim it will do the first year. I kept the live stock off of it for fear they would tear or tramp it out during the rainy season. When our heavy fogs came inland it died down to the ground. In February, 1899, we had frost 10° above zero. When harvest time came I could not see a single head of it. Since the fall rain has come it has sprouted again. The longest stem I could find was 10 inches high. The present status agrees with all I have read about, namely, not much growth the first year, but will mature the second year.

Mr. W. A. Wintermeier, Silvies, Harney County:

A decayed lava and clay soil was used. The ground was plowed 10 inches deep, leveled off and harrowed, and the seed sown the 1st of May. After sowing, the ground was harrowed again and rolled. The grass grew from 3 to 12 inches high, forming a good thick stand. It does not grow very tall, but forms a heavy sod. We have had some very cold weather, but the grass is still green.

SOUTH DAKOTA.

Mr. H. C. Bockoven, Clark, Clark County:

The seed was sown broadcast on April 10, 1898, and harrowed in. The soil was a black loam in good condition and was plowed and harrowed. The grass bloomed June 25, was ripe July 15, and was harvested on the latter date. The quality of the product was good, and it seems to be a valuable grass for a dry climate. It grows well and stands the dry weather better than most other grasses. It has a large amount of leaf growth at the bottom, making it valuable for pasture as well as hay.

Mr. W. H. H. Phillips, Brookings, Brookings County:

A black loamy soil was plowed in the fall of 1897, well harrowed, and the brome seed sown by hand about April 17, 1898. It was cut the last week in July with the binder for seed. There would have been probably from 1½ to 2 tons of fine hay. It covered the ground well in August, 1898, and was green until December. It is a very promising grass. I shall distribute some seed to a few good farmers and sow the rest on my land in 1900.

Mr. D. Roberts, Faulkton, Faulk County:

The seed was sown broadcast April 1, 1895, and April 10, 1898, with one-half bushel of spring rye, and lightly harrowed in and rolled. The land was dark prairie soil that had been cultivated ten years. It was manured lightly three years ago with barnyard manure. The ground was well prepared and the seed sown early in the spring. The grass bloomed July 15 and ripened from August 1 to 10. It was cut for seed about August 1 to 10, then followed with a mower for hay. It was well seeded and matured. The grass is a very strong grower, with thick, leafy bottom from 12 to 16 inches high, and seed stalks running up 12 to 14 inches higher are well loaded with seed. Stock is fond of it, and it has every appearance of making hay equal to or better than timothy.

Mr. A. B. Smedley, Millbank, Grant County:

The seed was sown in spring of 1898 with wheat as early as the ground could be worked. I harvested July 15, when fairly headed, and cut for hay before ripening. It produced 2 tons of hay per acre of excellent quality. As hay is never sold from my farm I can not say of what value it is, but for feeding it is fully equal to timothy or clover.

Mr. E. T. Stevens, Woonsocket, Sanborn County:

I sowed some of the seed with spring wheat and oats after the grain was in and did not harrow it; it did not grow. The rest was sown alone on ground that had been well prepared and cultivated; it was fine. I saved the seed, and will sow again next spring. This spring, April, 1899, I sowed one-half acre of old ground and dragged it thoroughly; the grass came up nicely. This spring it was two weeks ahead of any other grass to start into growth. I saved the seed on the 1st of August. The plants were about 30 inches high, with a very thick undergrowth; the product is excellent. One of my neighbors east of me has 10 acres that is immense; it is on shady ground, while mine is on high land. I think it is just the kind of grass that we want for this country.

Hon. H. C. Warner, Forestburg, Sanborn County:

Five different methods were adopted in planting the seed:

Experiment 1. A field of river-bottom land was used. The seed was sown on the unbroken sod, then the land was thoroughly harrowed. This gave 30 per cent of a stand.

Experiment 2. A dry upland pasture was used and the land was pulverized and harrowed before sowing. This gave 5 per cent of a stand.

Experiment 3. A dry upland pasture that had been pastured for sixteen years was used. The land was pulverized both ways and the seed sown and harrowed in. It came up well, but the young plants were exterminated by a drought of four months.

Experiment 4. The land, which had been cultivated for some time, was plowed and well prepared; the brome seed was sown with oats as a nurse crop. This gave 95 per cent of a stand.

Experiment 5. The land was plowed and well prepared as in the preceding instance; the brome seed was sown with wheat as a nurse crop. This gave a perfect stand, and is this season a perfect meadow.

The brome grass will stand cold and drought without killing after the first year. Wheat is better than oats for a nurse crop. On sod a better stand can be secured by sowing the seed first and then pulverizing it in. It is a perfect hay or pasture grass for the Northwest.

TENNESSEE.

Mr. H. G. Dail, Dutch Valley, Anderson County:

A light soil with clay subsoil was used that would produce 20 bushels of corn per acre. The land was plowed and disked, then dragged and worked fine. The seed was sown broadcast about May 15, 1898, and brushed in. I did not harvest any except to give some to the stock. They ate it with relish. It is rather coarse in quality. I think this grass will be good for pasture, as it seems to stool like orchard grass or oat grass. It is thin on the ground and has not yet made turf. I think, from what I know of it, it will be best for pasture, as it bunches on the ground and is now (October 18, 1899) 7 or 8 inches high.

Mr. Paul F. Kefauver, Madisonville, Monroe County:

A heavy, clay, fertile loam was used. On February 19, 1898, 35 pounds of seed were mixed with 150 pounds of complete fertilizer and drilled in with common wheat drills. The season was good and the grass made a good stand, although not so good as either the redtop and timothy or the orchard grass plats adjoining, which were sown April 12 and March 1, respectively.

TEXAS.

Mr. G. A. Graham, Graham, Young County:

A black, sandy soil with a red clay marly subsoil was used, which had been thoroughly plowed and harrowed. The seed was sown September 25, 1899, after a slight shower and raked in by hand. A heavy rain fell October 26, when the seed commenced coming up. It is now 3 or 4 inches high. We have had two frosts, and it has received no injury. I am pleased with its appearance and growth.

UTAH.

Mr. James Lofthouse, Paradise, Cache County:

The seed was sown broadcast April 25, 1898, and harrowed in on a dry, rather poor, loamy upland or bench land that had been plowed the previous fall and disked in the spring. The grass was not harvested, as it did not grow high enough. I think it will be very valuable, as it looks nice and green now (November 21).

Mr. Samuel Roskelley, Logan, Cache County:

The seed was sown broadcast by hand April 30, 1898, and harrowed in with a light harrow. The soil was strong sage-brush upland that had been well plowed last fall and replowed in the spring, and thoroughly harrowed. The seed came up nicely without further cultivation. The grass bloomed July 27. It headed out nicely, but did not fully mature on account of drought. I regard it as an excellent drought-resisting forage plant.

WASHINGTON.

Mr. Frank Bacon, Rockford, Spokane County:

The seed was sown on white-clay hilly land that was too poor for spring wheat. It was sown April 12, 1898. The ground was plowed twice and harrowed down fine the summer of 1897, and by rebreaking was in fine condition for sowing. After passing through severe droughts, such as are common here, the grass made a good stand and remarkable growth, and I, as well as my neighbors and all who have seen it, regard it as valuable for this dry, arid country. It is now (October 20, 1899) a beautiful sight. It keeps green and its value for nice pasturage can not be overestimated. The brome grass will not be used for hay, but through the long, dusty, frightful droughts it will be of great value for pasture.

Mr. F. A. English, Farmington, Whitman County:

The seed was sown broadcast by hand April 12, 1898, and dragged over with flattened heel harrow. The soil had been plowed and harrowed thoroughly in the early spring, about a week before planting. The grass was cut in August to increase root development. The growth is fine and will make a record during the coming year. This plat was sown in the poorest land on the farm—high, dry hill land, gravelly and unfit for any other crop. The season was the driest and hottest during twenty years, there being no rainfall during July, August, and half of September. The grass should be planted extensively. I have a number one stand for next year, and I am satisfied that it will make a fine crop of hay and also good late pasture. I can recommend Bromus inermis as a truly wonderful plant for dry climates, producing fine hay and pasturage.

Mr. W. E. Lawrence, Toppenish, Yakima County:

New bottom land was plowed 8 inches deep, then the seed was sown, harrowed in, and rolled hard. At this date (October 2) it is getting thicker and furnishes more pasture than any other grass grown here..

Prof. W. J. Spillman, State Experiment station, Pullman, Whitman County:

The seed was sown on clay loam upland, 2,500 feet altitude, in good tilth. Three years' experience indicates that this is the best grass for meadow and pasture for the uplands of eastern Washington. I pastured 1.9 head of cows per day from May 13 to September 1, 1897, on one acre of this grass. Horses especially relish hay made from it.

Mr. Nelson Williams, Chewelah, Stevens County:

The seed was sown broadcast May 2, 1898, on a sandy loam and harrowed in. The land was comparatively new, at one time covered with timber, and was plowed and harrowed before seeding. The grass was not cut, as it did not grow tall enough. The growth was very slow, but there appears to be a good stand.

WISCONSIN.

Mr. J. F. Jensen, Waupaca, Waupaca County:

The seed was sown broadcast on April 25, 1898, with a hand seeder and covered with a light harrow. It was sown with oats as a nurse crop. The soil is clay loam, and was fall plowed and well cultivated in spring before sowing. The grass made a fair growth in the oats, although the season was a dry one. In 1899 the yield per acre was about 1½ tons of hay of good quality, even better than timothy. I think this grass very valuable, especially for pasture, as it will make quite a growth very early in the spring, before even timothy starts. It also grows very late in the fall and forms a very thick sod.

WYOMING.

Mr. John Baugh, Carlile, Crook County:

The seed was sown early in 1898. The whole season was so dry that it did little more than come through the ground, and what few plants came up were too enfeebled to do much. I have a small piece of the same grass in a favored place that gets well wet in the spring. It yields a heavy crop each year.

Mr. G. A. Bell, Hyattville, Bighorn County:

The soil is a dark, sandy, river-bottom loam which had been in cultivation for three years. One year ago it was manured heavily. The land had been plowed 8 inches deep. The seed was sown broadcast on April 10, 1898. The grass stands frost well, but requires a little more irrigating than timothy. I think it will make a better fall pasture than timothy. It was cut for seed August 15, 1898. I consider this a valuable grass, as it will stand any amount of dry weather and not die out, and will start growing as soon as irrigated. It grows tall, does not lodge easily, and makes very good early pasture in the spring.

Mr. Kirk Dyer, Little Medicine, Albany County:

The seed was sown April 20, 1898, after spring wheat and harrowed in. The soil is clayey loam that has been in cultivation several years. It was highly fertilized with barnyard manure and in excellent condition. The wheat was cut September 1, and there was a nice, thick stand of Bromus inermis probably 6 to 10 inches high. The experiment is encouraging and the progress of the crop fully equal to timothy the first year.

Mr. W. R. Williams, Tensleep, Bighorn County:

The seed was sown May 20, 1898, on ground plowed 5 inches deep, leveled nicely, and the seed covered with a harrow. The soil is red gypsum with a deep subsoil and was in good condition. The grass was irrigated three times. I got a good stand, but can not tell much about the value of the grass the first year.

RESCUE GRASS (Bromus unioloides.)

An erect, strong-growing annual or perennial grass, 1 to 3 feet high, with numerous long, tender, broad leaves, usually spreading panicles and large, much flattened, drooping spikelets. It is known also as Schrader's brome, Australian oats, Australian brome, and Arctic grass, and is a native of South America and the southwestern portion of the United States. As a rule rescue grass dies the first year after seeding, but if it is grazed closely and not allowed to go to seed it may be used as pasture for two or three years. During the dry summer weather the tips of the leaves turn yellow, but this does not injure the mass of foliage, which remains green and produces fine forage. There are now several forms of this species which vary according to the height of the plant, breadth of the leaves, and the abundance of seed produced on the panicle. In the grass garden of the United States Department of Agriculture, Washington, D. C., rescue grass produces excellent pasturage throughout the summer and fall. It seems to be perennial here, as several plats that have been growing in the garden for several years continue to produce an abundance of dense pasturage every season. The leaves are slightly injured by frosts in early spring and fall. A second growth of 6 inches or more comes up about August 4, after the hay has been cut.

In California it is considered one of the best and most useful grasses for dry lands, being the earliest and best winter-growing grass. As it makes its chief growth during the colder months of the year, it has come to be regarded as one of the best winter grasses for the South. The seed may be sown in August or September at the rate of from 30 to 40 pounds to an acre.

Forty-eight packages of rescue grass have been distributed since 1896, and 10 experimenters have reported, recording four failures, one unsatisfactory, one excellent, and four good results.

The following are some of the reports that have been received:

Messrs. W. Atlee Burpee & Co., Doylestown, Bucks County, Pa.:

A rich, loamy soil was plowed, harrowed, and hand ranked. The seed was sown in shallow drills on May 4, 1898. The stand was good and left until the following season, the tops being removed, but its height not ascertained. On September 22 there was a good stand and fine growth, with quite a good lot of seed heads. At this time (November) it seems to be identical with *Bromus schraderi*, and has made a much stronger growth than the sample of *Bromus breviaristatus* sent us.

Mr. H. T. Fuchs, Tiger Mill, Burnet County, Tex.:

The land was plowed once and the seed sown at different times throughout the year. The seed sown in the fall after the first rain, about October or November, did the best. It grew much better on cultivated land than I ever saw it grow before. In its native state here it comes up in the fall and grows all winter, then goes to seed in May or April, and as soon as the seed ripens and drops, the grass dies. The crop of rescue grass was cut while the sun was very hot, and it cured in one day. As it is never all in full bloom at one time, but flowers gradually head after head, it is difficult to set the best time for cutting. If well cured it is liked very much by horses, cattle, and other stock. This grass is quite valuable, especially because it is hardly ever injured by frost, and comes up where nothing else is growing. It makes a splendid range for hogs and other stock during the winter. Poultry are also fond of it in winter.

SHORT-AWNED BROME GRASS (Bromus breviaristatus).

An erect, robust, native grass, 2 to 4 feet high, with numerous large leaves and long, closely appressed branches to the panicle. In Wyoming and Montana it occurs in the open woods among the mountains, where it sometimes forms meadow-like tracts of considerable extent at an altitude of from 5,000 to 8,000 feet. It has been introduced and grown for a number of years in central and western Iowa, where, under favorable conditions, two crops may be cut in a single season. In Colorado it is found to be valuable in the native meadows at an altitude of from 6,000 to 9,500 feet. Short-awned brome grass produces an abundance of leaves, which are well liked by stock. Although not so valuable as the smooth brome grass, yet it is worthy of being extensively tried, especially in meadows at high altitudes. Its cultivation has been carried on to some extent in the Northwest, with very promising results.

In the grass garden of the Department of Agriculture, Washington, D. C., this grass makes a very promising growth. As early as March 28 there is a nice even growth from 4 to 6 inches high. In June, when about 1½ feet high, it blooms, and after being cut produces a dense, vigorous, leafy growth, 1½ feet high, which is not affected by the dry, summer weather, and continues to afford good pasture along into November and December without being injured by frosts.

Twenty-eight packages of the seed of short-awned brome grass were distributed in the spring of 1899. It is, as yet, too early to receive reports from the experimenters. Two, however, have been received, recording very promising results.

Mr. Thomas Ashcroft, Ashcroft, Harding County, S. Dak.:

A loamy soil was plowed and harrowed. The seed was sown with a few oats about the end of May, 1899. The oats were cut in September, but the grass was not high enough to add anything to the bulk of the hay, although it was nice and bunchy. I was well pleased with it.

Prof. D. A. Saunders, Brookings, S. Dak.:

The seed was sown in drills in April, 1899. Only a few rows were planted. It made a good growth and stood the drought perfectly.

SIDE OATS GRAMA (Bouteloua curtipendula).

(Plate IV, fig. 1.)

A tall, stout-stemmed, tufted native grass, 1 to 3 feet high, with tough, perennial, fibrous roots and long pointed leaves. The inflorescence consists of a number of short reflexed spikes which are arranged along the upper portion of the stem. Its range extends from New Jersey westward to the Rocky Mountains and southward, through Texas, into Mexico. Where abundant, it is said to make good hay and pasture which is readily eaten by stock. Side oats grama has not yet been extensively introduced into cultivation. In the grass garden of the Department of Agriculture, Washington, D. C., this grass made a luxuriant growth all through the dry summer weather of 1899, producing excellent hay. An aftermath 7 inches high, of fair quality for pasturage, was produced, which was not injured until severe frosts on November 28, when the leaves all dried up. Our special agent at Walla Walla, Wash., reports that it has done well there, producing an abundance of seed, and that it is quite as valuable as the blue grama. In the hills of central and western Iowa and parts of Nebraska it is highly valued by farmers for hay, as it cures readily, and even when cut late in the season the leaves retain their freshness longer than many of the other wild grasses in those regions. The growth of this grass should be encouraged, as it will withstand long periods of drought, and is so deeply rooted that it is not easily injured by grazing. Since 1896, 71 packages of the seed of side oats grama have been distributed and 19 reports have been received from the experimenters. This large difference between the number of packages distributed is due to the fact that 60 of these were sent out in 1896, when no report blanks were sent out and no requests made for a report on the trials. Out of the 19 reports received 3 were failures, 7 unsatisfactory, and 9 good. The following are the most favorable reports that have been received:

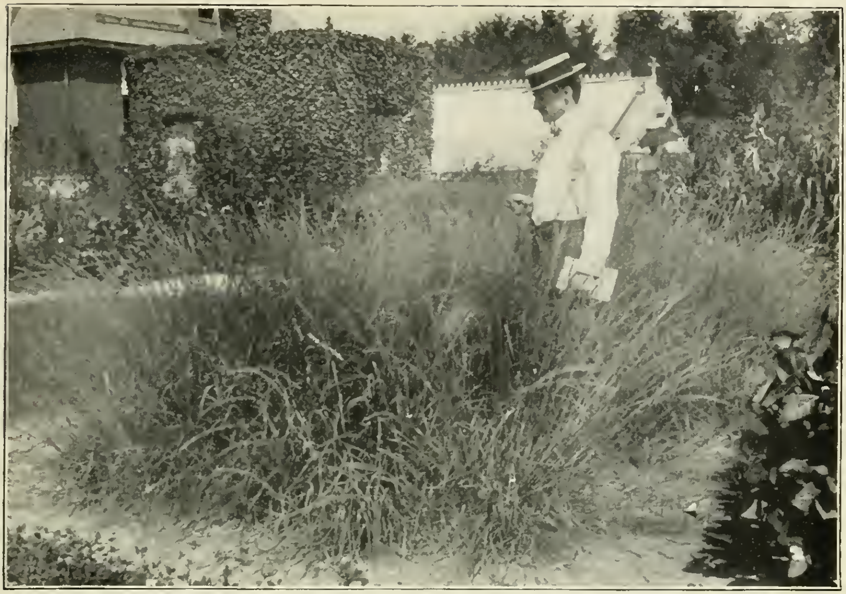


FIG. 1.—SIDE OATS GRAMA, GRASS GARDEN, WASHINGTON, D. C.

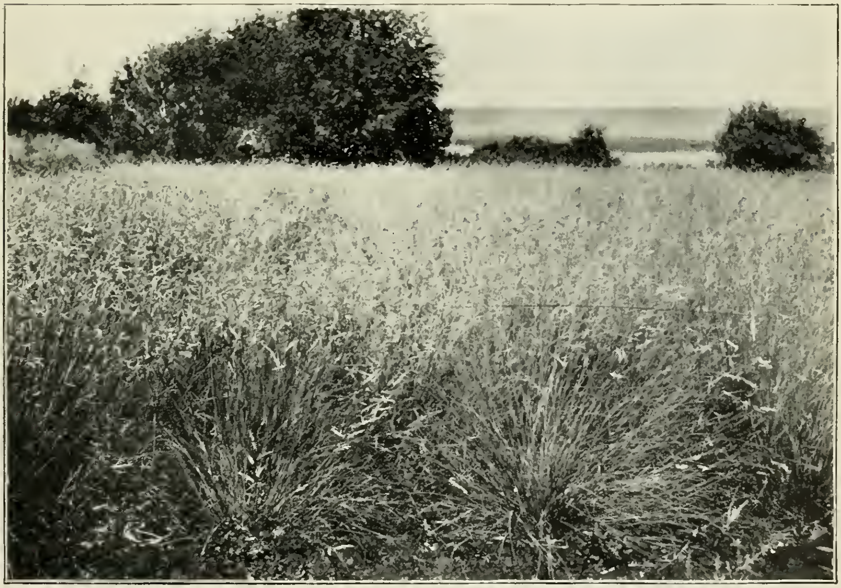


FIG. 2.—BLUE GRAMA (BOUTELOUA OLIGOSTACHYA) AS GROWN IN GRASS STATION AT WALLA WALLA, WASH.

From a photograph by A. B. Leckenby.

Mr. G. W. Covey, Laddonia, Audrian County, Mo.:

The seed was sown in an old orchard where the hogs had been rooting. It did very well.

Mr. J. S. Holmes, Bowmans Bluff, Henderson County, N. C.:

The seed was sown in two different plats. Plat A was fairly good upland soil on a steep hillside, facing the east, with a yellow clay subsoil. Plat B was poor, sandy, bottom land close to the river. The ground was plowed and harrowed and the seed sown broadcast on April 8, 1897, at the rate of 30 pounds to the acre. Plat A was harrowed in and plat B was covered with a garden rake. Plat A looks well and is taller than the trial plat of blue grama, but not so thick on the ground. We have had the thermometer down to 12° already, without snow, and it has not killed it. On plat B there is not a single plant. It came up all right, but was killed by the summer drought. Plat A survived the winter very well and quite a lot of it bloomed in the summer of 1898.

Mr. T. P. Kerr, Cambray, Donna Ana County, N. Mex.:

The seed was sown on alluvial soil in July. This is a native grass and did well. In its wild state it makes fine hay when it has plenty of rain.

Prof. T. L. Lyon, Experiment Station, Lincoln, Nebr.:

An upland, loamy soil, with considerable alkali and a tendency to pack, was used. The ground was plowed 8 inches deep and worked to a fine tilth. The seed was sown in rows, 6 inches apart, on May 5, 1897, on a 3 by 3 foot plat, and again broadcast May 30 on one-tenth of an acre. The grass bloomed about the first of August, 1898, and ripened about the end of August. The yield per acre was about 3½ tons of good feed. This is a promising grass for cultivation as it seeds abundantly and furnishes a large quantity of good hay. It has the disadvantage of starting its growth late in the spring and drying up in midsummer. It is not so hardy under cultivation as in the wild state, for all of it was killed out in the winter of 1898–99.

Mr. L. Miles, Sheridan, Kingfisher County, Okla.:

Some bottom land was well plowed and harrowed. The seed was sown broadcast on March 20 on timber land. None of this germinated, so I sowed again on April 2 on well-prepared soil. The seed ripened about August 15. I don't feel like condemning it, but I think trouble would be experienced in getting it to start, as our soil dries quickly after rain.

Mr. Samuel Roskelley, Logan, Cache County, Utah:

A virgin sage-brush upland was plowed 5 inches deep, harrowed, replowed 8 inches deep, then thoroughly harrowed. The seed was sown broadcast on April 16, 1897, and covered with a slanting-tooth harrow. I cut the crop on August 2, 1897, when it was just out of bloom, in order to save what I could, as the drought began to dry it up fast. It seemed to do reasonably well for the chance it had. The yield was about 2 tons per acre. It will no doubt make a good crop of hay of good quality. It withstood the drought better than the other varieties.

Mr. G. D. Tillman, Clarks Mills, Lexington County, S. C.:

The land was freestone soil in which grasses and forage plants are at a great disadvantage, owing to the lack of lime. The side oats grama is doing well and promises to be a good grass for this country. It spreads slowly, but surely, and stock likes it.

Mr. Henry Wehry, North Vernon, Jennings County, Ind.:

The soil was a stiff clay, underlaid with slate and fertile enough to produce any kind of a crop. The ground was plowed and harrowed and the seed was sown in drills 6 inches apart on April 24, 1897. So far as I could observe the quality of the product was good. The yield was not large, but the rapid growth would perhaps fully repay the shortage of the yield. I consider it a valuable addition to our pasture grasses; a good variety to sow in a mixture for permanent pasture. We had plenty of rain all season.

BLUE GRAMA (Bouteloua oligostachya).

(Plate IV, fig. 2.)

A somewhat tufted or matted perennial, 6 inches to 2 feet high, with strong-growing rootstocks and numerous basal leaves. The inflorescence consists of usually 2 one-sided spikes on slender stems. It extends westward from Wisconsin to California and southward into Texas and northern Mexico. This grass improves very rapidly under cultivation. For several years it has grown luxuriantly in the experimental grounds of the Department at Washington, D. C., starting to green out about the middle of April and growing from 1½ to 2½ feet high, varying with the seasons. It is in full bloom about the middle of July and produces a fine growth of excellent hay. A fine aftermath appears soon after cutting, which affords excellent pasturage until injured by severe frosts in November.

No other grass better withstands the trampling of stock, and on the ranges it is considered among the very best for grazing purposes. During the dry season it cures in the turf into perfect hay, which is said to lose none of its nutritive value. Cattle are pastured on this hay all winter in the eastern Rocky Mountain region, where it is regarded as an exceedingly valuable grass.

Since 1896, 70 packages of the seed of blue grama have been distributed, but only 14 reports have been received. Of these, 5 experimenters failed to get any result, 3 considered it of little value, and 6 regarded it as a valuable grass for their districts.

The following are some of the reports that have been received from different States with widely varying climatic conditions:

Mr. J. S. Holmes, Bowmans Bluff, Henderson County, N. C.:

The land used was fairly good upland on a steep hillside facing the east. The seed was sown broadcast on April 8, 1898, and harrowed in. At this date, January 18, 1899, the grass looks quite alive and ready to make a good growth next year. It stood the long drought of August, September, and October, and seems to promise better than side oats grama (*Bouteloua curtipendula*).

Mr. P. T. Kerr, Cambray, Donna Ana County, N. Mex.:

This is a native grass and known here as grama, and grows luxuriantly when it has plenty of water. It is valued as fine grazing for both horses and cattle.

Mr. Henry W. Merrill, Hiram, Oxford County, Me.:

This grass did very well the first season, but I could not find a trace of it the following year.

Mr Samuel Roskelly, Logan, Cache County, Utah:

The land used was a virgin sage brush upland, which was plowed 5 inches deep, harrowed, replowed 8 inches deep, then thoroughly harrowed again. The seed was sown April 16, 1897, and covered lightly with a slanting-tooth harrow. It was in full bloom about July 20 and cut August 2, to save what I could, as drought began to affect it considerably. The hay was of good quality and yielded probably about 1½ tons to the acre. The stand was rather poor, but what did come seems to have taken root well.

Mr. Henry Wehry, North Vernon, Jennings County, Ind.:

The seed was sown on well-prepared clay loam in the spring of 1898. The hay was of good quality, but the yield small. It does not grow quite as large as the side oats grama (*Bouteloua curtipendula*), but otherwise it is fully equal to it and would be a good grass to put in a mixture for permanent pastures.

BERMUDA GRASS (Cynodon dactylon).

A perennial grass, with a creeping habit of growth and upright flowering stems, which terminate in a finger-like inflorescence. It is dispersed throughout the tropical regions and warmer countries of the globe. Its value as a pasture grass is said to have been first noticed in this country by the late General Bethune, of Georgia, about 1825, who planted it in many places throughout the States. When the soil is poor the leaves are short and the upright stems only a few inches high, but on good land it grows to a height of 2 feet and yields a considerable amount of excellent hay. Throughout the South it is extensively used as a lawn grass where the grasses ordinarily used for lawns could not survive. The leaves, however, turn brown with the first frosts, so that it is only in the summer that this grass produces a green and pleasing lawn. The quickest method of producing a lawn of Bermuda grass is by cutting up a piece of the turf into small pieces and transplanting these from 6 inches to 1 foot apart. When once established, it is very persistent and difficult to eradicate, hence the advisability of keeping it out of land which is likely to be used for other crops. Bermuda grass does not mature seed, except in the extreme southern portion of our country, but imported seed can be obtained from the leading seedsmen. A variety known as St. Lucie grass is regarded as more desirable for lawns than the ordinary form, as it is of a finer texture, grows more rapidly, and is said to withstand quite severe frosts. As it does not root so deeply, it is less liable to become a pest by spreading into cultivated fields.

Since 1896, 22 packages of Bermuda grass have been distributed and 10 experimenters have complied with our request for a report on their success or failure. Out of these, 5 speak of it very highly and regard it as a valuable forage plant, 3 consider it of but little value, while 2 report complete failures.

The following reports will indicate the great value of Bermuda and St. Lucie grass to the South:

Mr. B. Atkinson, Waverly, Camden County, Ga.:

A well-drained, diked, river-bottom land was used. The soil was plowed and harrowed and the seed sown in drills about 2 feet apart. This experiment proved to be very satisfactory for the first year, but it is in the second year that there is profit in Bermuda grass. I have no doubt but that next year this experimental plot of land will yield at the rate of 4 tons to the acre.

Mr. F. A. Hendry, Thompson, Lee County, Fla.:

A package of Bermuda grass seed was received several years ago from the Department. It was sown broadcast and harrowed in. The seed usually matures about October, but sometimes earlier. For pasturage it is excellent, but I have never cut any for hay. It stands at the head of the list on rich, cultivated, moist lands, and under favorable conditions would produce at least 2 tons to the acre. It may be mown two or three times during the year.

Mr. E. O. Mitchell, Chattanooga, Hamilton County, Tenn.:

A small amount of the St. Lucie grass was sent to me last winter from Florida by mail. It was green when received, and in three days after it was planted we had a severe cold spell, the mercury going down 10° below zero. It withstood this and grew right along. A few days ago we transplanted from the parent bed a plot of ground about 12 feet square, and there is at present enough to plant another plot of equal size. This shows its aggressiveness. The parent stalks have thrown out runners in some instances 4 feet long, taking root at every joint. I have also the common Bermuda grass, but it does not appear to be nearly so aggressive as the St. Lucie. Furthermore, the St. Lucie remains green throughout heavy frosts. The friends who sent the sample to us said that frost could not kill it.

GIANT LYME-GRASS (Elymus condensatus).

(Plate V, fig. 1.)

A stout, erect, native perennial, 5 to 10 feet high, with long, flat, rigid leaves, dense spikes, and strong spreading rootstocks. It is common in the Rocky Mountain region and on the Pacific Slope, where it is found useful for holding the sand on railway banks. When young it makes hay of fair quality, and when allowed to stand it affords a considerable amount of forage for stock on the winter ranges.

Twenty-four packages have been distributed since 1896, but only 4 reports have been received, with 2 failures, 1 unsatisfactory, and 1 with good results.

Mr. George T. McWhorter, Riverton, Colbert County, Ala., reports as follows:

The seed was sown broadcast on a deep, smooth bed on March 1, 1899. It died down during the dry summer weather, but thrived after the fall rains and now looks well.

CANADIAN LYME-GRASS (Elymus canadensis).

(Plate V, fig. 2.)

A rather stout, smooth perennial, 3 to 5 feet high, with broad, flat leaves, 6 to 12 inches long. The inflorescence is in the form of a head

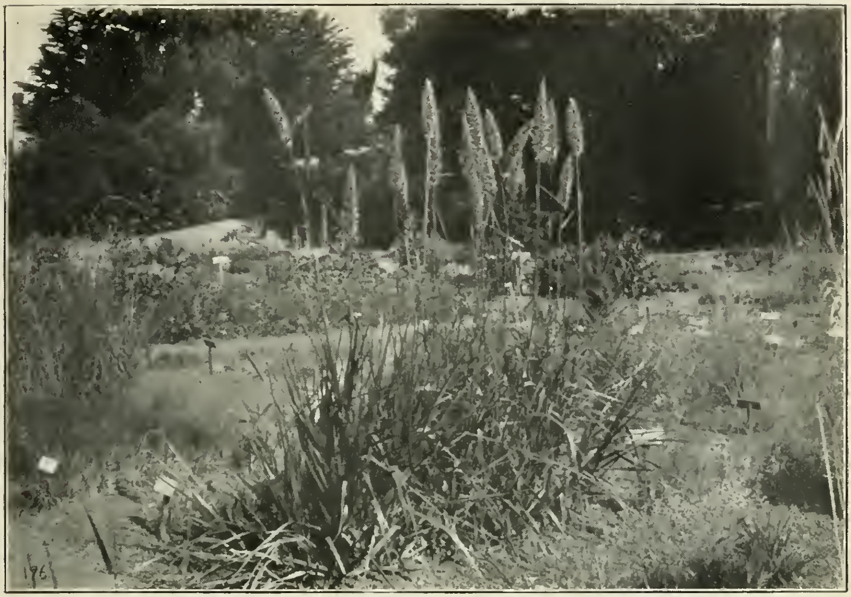


Fig. 1.—Giant Lyme Grass (Elymus condensatus) at Experiment Station, Berkeley, Cal.

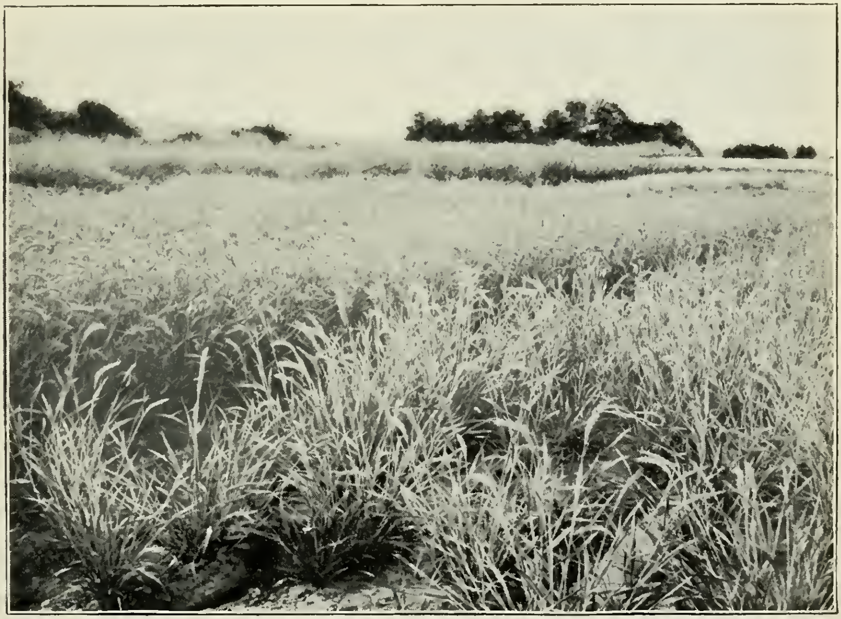


Fig. 2.—View in Grass Station at Walla Walla, Wash., Showing Canadian Rye Grass (Elymus canadensis).

From a photograph by F. Lamson-Scribner.

resembling the cultivated rye. It is found in almost all parts of the country in low thickets and along streams in rich, open woods. So far this grass has received very little attention. Some recent experiments, however, indicate that it has considerable value for pasture and hay. In the Northwest it is regarded as of some agricultural value for early pasturage, and in some places yields an excellent crop of hay. Mr. A. B. Leckenby, our special agent in charge of the grass and forage plant investigations on the Pacific coast, reports that it did remarkably well, producing two crops of seed, and suggests that it might be a useful grass to bring into cultivation. An equally good report comes from our special agent, Mr. H. L. Bentley, at Abilene, Tex. He found that it did well both on moist and dry land. It seeded out well and stood the long severe drought remarkably. The quality of the hay produced was very fine, and he considers it the best hay grass native to that part of Texas. The following is extracted from his report:

> There are thousands of acres of moist valley lands that are annually cultivated in cotton and corn that could be put down to Canadian lyme-grass to much better advantage. I am satisfied that average valley lands in this section fairly well seeded with this grass will yield two good crops of hay every year, and that even a third crop is possible. After a second cutting here this year, in spite of the worst and longest drought ever known in this part of Texas, the third crop is now 12 to 16 inches tall and would afford excellent pasturage.

On the experimental grounds of the Department at Washington, D. C., this grass has also done very well, producing a fine growth 2½ to 3 feet high. It was in full bloom about July 1, and cut for seed when fully ripe about August 15. By September 7 a vigorous aftermath 1 foot high had grown, which would have afforded excellent pasturage. The tufts are still (November 27) growing vigorously, although the tips of some of the leaves are yellowed by the heavy frosts. Twenty-two trial packages of the seed of Canadian lyme-grass have been distributed by this Division since 1896, but only 6 reports have been received. Of these 2 were failures, 2 unsatisfactory, and 2 good.

Mr. George T. McWhorter, Riverton, Colbert County, Ala., reports as follows:

> The seed was sown on a well-prepared bed on March 1, 1899, and kept free from weeds. It came up, but died down during the summer, reviving again with the fall rains. We had a very long protracted drought this year, so that it is no criterion. It promises better than anything sown except buffalo grass.

MEADOW FESCUE: ENGLISH BLUE-GRASS (Festuca pratensis).

Meadow fescue is an erect, robust perennial, from 2 to 4 feet high, with numerous linear, glossy-green leaves and a branched panicle which is inclined to one side. It succeeds best on rather moist clay soils, such as are commonly found along creek bottoms, but will grow on almost all soils. As it is one of the earliest grasses in the spring, and one of the latest in the fall, it makes an excellent grass for fall and winter pasturage. This is one of the most common of the fescue grasses, and, although introduced into this country from Great Britain over a hundred years ago, it does not yet receive the attention which it deserves. It is sometimes known as Randall grass, evergreen grass, and English blue grass, the last an unfortunate name, as it in no way resembles the *Poas*, or true blue grasses. Many of our experimenters took this to be the Kentucky blue grass, and in consequence did not even attempt to sow the seed. The forage is much relished by cattle, either green or when cured for hay. When grown for hay it should always be mixed with other grasses. Redtop and alsike clover will grow well on the same kinds of soil, and the three make an excellent mixture for either temporary or permanent pastures.

A large quantity of the seed of meadow fescue was secured for the Department, through Prof. N. E. Hansen, during his visit to Russia, in 1898. This Division, through the Section of Seed and Plant Introduction, has distributed 424 packages, of 1½ pounds each, sufficient to sow one-twentieth of an acre, to all parts of the United States. One hundred and one reports have been received from the experimenters, giving in detail the results obtained and their estimates of its value. Very favorable reports have been received from Georgia, Indiana, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, Oregon, Washington, and Wyoming.

The following are some of these testimonials which have been received from the different States:

GEORGIA.

Mr. E. J. Hartman, Orr, Gilmer County:

The English blue grass has done splendidly so far. It seems to be an excellent grass for sheep, and if mixed with other grasses does also for cattle.

Mr. B. Lumsden, Macon, Bibb County:

The seed was received too late to sow. I planted some this spring near my fish pond in the shade and it is now looking quite well.

INDIANA.

Mr. Henry Wehry, North Vernon, Jennings County:

It seems to be well adapted to moist soils, as it grew to be 4 feet high and also made a good growth after it was cut for hay. It would be a splendid pasture grass.

IOWA.

Mr. C. Steinman, Mapleton, Monona County:

The seed was sown with oats about the last of April and did well.

Mr. S. H. Talley, Packwood, Jefferson County:

The quality of the product is very good. I think it an excellent grass for pasture. It grew three feet high the present year and is very hardy as to drought.

KANSAS.

Mr. Clark Belles, Burlington, Coffey County:

The seed was sown broadcast and the land afterwards harrowed twice with a smoothing harrow. The growth of this grass is about the same as the common meadow fescue that is grown to quite an extent in this country. It is quite valuable for seed, but not thought much of for pasture or hay.

Mr. A. Y. Bentley, Wallace, Wallace County:

The seed was sown by hand on a good clay loam on April 4, 1898, and covered with a garden rake. It was kept cut with a lawn mower once every ten days until late, then let go to seed. A fine growth was produced, and it is a good spreader. I think it will prove one of the best grasses for this climate.

Mr. N. Christensen, Mariadahl, Pottawatomie County:

The seed was sown in March. The grass grew well, and was mown two or three times with a lawn mower. It makes a good sod.

Mr. T. E. Pearce, Edgerton, Johnson County:

The English bluegrass was sown broadcast and lightly harrowed in. It grew well, but has not seeded yet, and will not for another year. When mixed with clover it makes one of our best pasture grasses. The yield of seed is about 8 to 20 bushels per acre. On good corn land it does well, but low, moist lands suit it best for heavy yields of pasturage. It is, perhaps, one of the most profitable pasture grasses we have. It starts to grow very early in spring, and grows very well in midsummer. It grows again very rapidly in the fall, unless extremely dry. After the seed crop is taken off, it can be cut later on for hay, which is very good.

MINNESOTA.

Mr. S. M. Warman, Sandstone, Pine County:

The yield per acre is about 2½ tons of hay of first-class quality. It grows rapidly and makes excellent pasturage. The hay is worth about $8 per ton.

MISSOURI.

Mr. G. W. Covey, Laddonia, Audrain County:

The seed was sown broadcast on a heavy clay loam on April 9. It has not headed, but has produced a fine growth, and now covers the ground like a thick carpet. We have had a number of killing frosts, but they have not affected it. I shall turn sheep in to eat the grass during the winter. I think it will prove a good thing for our soil and climate.

MONTANA.

Mr. Wm. Flannery, Bozeman, Gallatin County:

The seed was sown broadcast on June 7, on new land composed of a sandy loam, then harrowed, rolled, and harrowed again with a light harrow. The crop was irrigated twice. I secured a good stand, but I can not form an opinion of its value until it has wintered and grown for another year.

Wm. W. Gamble & Sons, Burton, Teton County:

The seed was sown on May 19 with a hand seeder. The crop was irrigated. I secured a fine stand, and it seems to do well, but I can tell better about it next year.

Mr. W. H. Heideman, Kalispell, Flathead County:

A very rich, black, sandy loam was plowed deep, well worked up, and harrowed twice before seeding. The seed was sown broadcast on May 3, 1898, and then harrowed and rolled. The ground was quite weedy, so the plot was cut with a mower to keep the weeds down. The grass has grown well, considering the dry season, and must have great drought-resisting powers. It has kept wonderfully green and fresh, and has made some growth this fall in spite of the little rain. I have great confidence in this grass, and am now giving it third place. I will report further on it in 1899. Now that another year has passed I think more of it. I can not praise it too much. It does not seem to mind dry and hot spells. It is probably best for pasture, but it makes good hay.

Mr. R. A. Reynolds, Dillon, Beaverhead County:

A rich, low, bench land was used which had been summer fallowed and well prepared. The seed was sown with oats May 1, 1898, at the rate of 3 pecks to the acre and dragged in. The crop was irrigated twice during the summer. A good thick stand was secured and it ought to make a fine crop next year. The oats grew too rank and shaded the grass too much. I think it ought to make a good grass for this country.

Mr. C. C. Willis, Plains, Missoula County:

The seed was sown May 1, but owing to the dry season it did not grow thick enough to harvest. It grew about 1 foot high and is fine for grazing. I can tell more about English blue grass next summer, as it takes one year to form a sod. It seems to stand the dry weather well, but it should have been sown the first of April.

NEBRASKA.

Mr. Alfred Shirley, Weeping Water, Cass County:

The seed was sown in March on the snow on the lawn. I secured a good stand, and I think it would be a good meadow or pasture grass. As it grows very rank, it is not good for lawns. I think it will be a success in this climate, as it is now in fine shape to stand the winter.

Mr. J. W. Williams, Weeping Water, Cass County:

The seed was sown broadcast April 6, 1898, and well harrowed in. I did not get a good stand, but what came up did very well.

NORTH DAKOTA.

Mr. William Britten, Sterling, Burleigh County:

It seemed to die down when drought set in about August 1, but turned green in September when the fall rains set in. I think it would do well for lawns or pasture on low wet lands, but I do not think it would succeed on upland.

Mr. J. W. Higgs, Silverleaf, Dickey County:

The seed was sown April 16. It came up well and made a good growth until June 15. The seed did not mature, but the grass looked nice and green up to November 1. I think it will make a fine pasture if once established.

OREGON.

Mr. E. R. Reames, Klamath Falls, Klamath County.

The seed was sown broadcast in May. The grass grew well and made a good growth. It was used for pasture.

Mr. J. O. Stemmler, Dora, Coos County:

The seed was sown broadcast April 10, 1898. It did not make much of a crop the first season and was not harvested until July 25, 1899. It grew about 2 feet high and produced about 20 bushels of seed per acre. It may prove to be of great value, as it seems to be adapted to this climate, ripens in good season, and makes a good growth.

WASHINGTON.

Mr. F. A. English, Farmington, Whitman County:

The seed was sown broadcast May 15, 1898, on a deep, black, loamy, summer-fallowed soil. I secured a fine crop, which was fully 5 feet high. The yield per acre was about 2½ tons of good hay. It is a very valuable grass for pasture or hay in good loamy soil, which is neither too wet nor too dry. I would recommend it for sections with soils like mine. It should be grown extensively.

WYOMING.

Mr. G. A. Bell, Hyattville, Bighorn County:

The English blue grass was very good. It stands drought well, but does not grow high enough for hay.

Mr. Robert Tait, Islay, Laramie County:

This seems to be a better grass for pasture than for hay, but it did very well for hay considering the backward spring and cold summer. I cut about the 1st of September, when it was nicely headed out and ripe. I think it a good grass for this climate.

CURLY MESQUIT (Hilaria cenchroides).

A delicate, perennial grass a few inches, to nearly 1 foot high, with slender, creeping runners and short, crisp leaves, which form a matted sward that improves under an amount of abuse and hard usage that would kill out less hardy grasses. It is one of the most valuable of the grasses of the dry plains and mesas of the Southwest, and in habit of growth closely resembles the true buffalo grass. During the summer it makes a dense, leafy turf, maturing on the ground, and in the fall and winter, when not rotted by late rains, affords excellent pasturage for all kinds of stock. No grass stands the long dry spells to which the Southwest is periodically subject better than curly mesquit. It commences to grow earlier in the spring than buffalo grass. Pastures may be sodded down to it by harrowing in bits of chopped up turf in the early spring after a rain, when the ground is soft, and in the course of a year a fine turf can be produced over the entire field. It is one of the best grasses for use in the renovation of the ranges. In dry summer weather it very often appears dead, but a few hours after a rain it becomes green again. Seed is produced in abundance, but it is difficult to harvest and of rather uncertain vitality.

Eighteen packages of the seed of this grass have been distributed for trial, but only one report has been received.

ITALIAN RYE GRASS (Lolium italicum).

A well-known, excellent hay and pasture grass introduced into this country from Europe about thirty-three years ago. It grows in broad, compact tufts, producing an immense growth of foliage from a single root cluster. Owing to its extremely rapid growth, cuttings may be obtained within three or four weeks from seeding, and at intervals of a month or six weeks successive crops may be harvested. Although it can be grown in almost all the States, it is better adapted to the middle latitudes and thrives best from southern Pennsylvania to Virginia. Because of its very rapid growth it is, like alfalfa, a good crop to rid land of weeds, as it quickly overshadows them, preventing the ripening of seed. This grass should always be cut for hay while in full bloom, as the stems rapidly become woody and unpalatable. It is not to be recommended for permanent pastures, as its duration is only two or three years; but for temporary meadows, and where a green growth is desired in a very short time it is an excellent grass. During the year 1898 twenty packages of the seed of this variety were distributed, and five reports have been received, two giving satisfactory results.

PERENNIAL RYE GRASS (Lolium perenne).

A vigorous perennial grass introduced into this country from Europe many years ago. On marshy lands, where the soil is good, it is one of the best pasture grasses. In such situations it will last from five to seven years, but on dry, sterile, upland soils it is short lived, rapidly disappearing after the second year. It stands pasturing well, and makes a quick recovery after having been closely cropped. The quality of the forage is very fine, being relished by all kinds of stock. For pasture on heavy soils in moist climates it is especially valuable, and under such conditions is largely used in mixtures for permanent pastures. As it grows very rapidly, a fine stand can be secured in a few weeks from the time of seeding. It is especially valuable when quick results are wanted and for covering the ground while other and more permanent varieties, like redtop or orchard grass, are becoming established. The form known as Pacey's perennial rye grass is said to be more vigorous than the species. Since 1896 twenty-five packages of perennial rye grass have been distributed, but only five experimenters have reported the results of their trials. The following are two of these reports:

Mr. Henry Wehry, North Vernon, Jennings County, Ind.:

> The soil used was a rather stiff clay, underlaid with slate and inclined to bake after hard rains. The ground was plowed and harrowed before sowing. The seed was sown April 24, 1897, in drills 6 inches apart, and cultivated twice between the rows during the season. The late sowing was altogether against it, so that it grew to be only about 4 inches high. I secured a good stand, and think it will be a valuable addition to our hay-producing grasses. We had plenty of rain during the entire season.

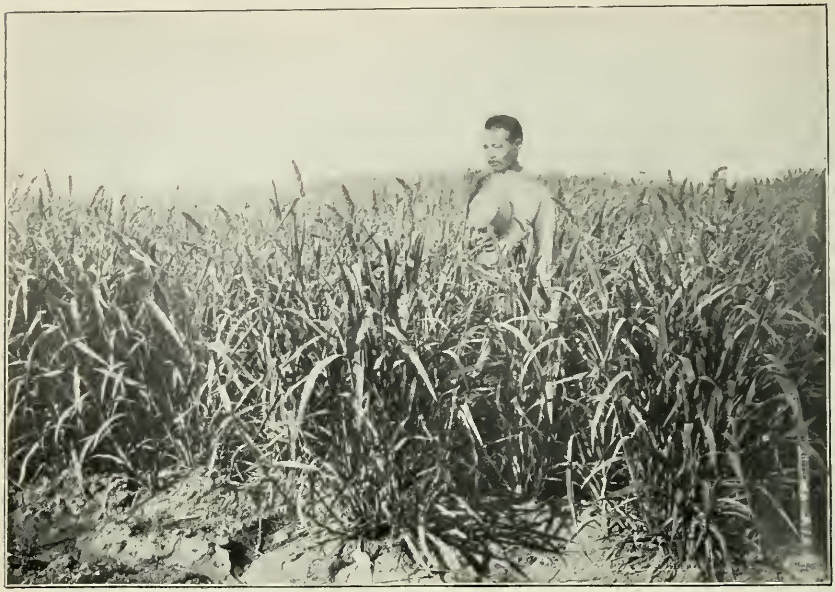


FIG. 1.—JAPANESE BARNYARD MILLET (PANICUM CRUS-GALLI), GROWN AT WALLA WALLA, WASH.

From a photograph by A. B. Leckenby.

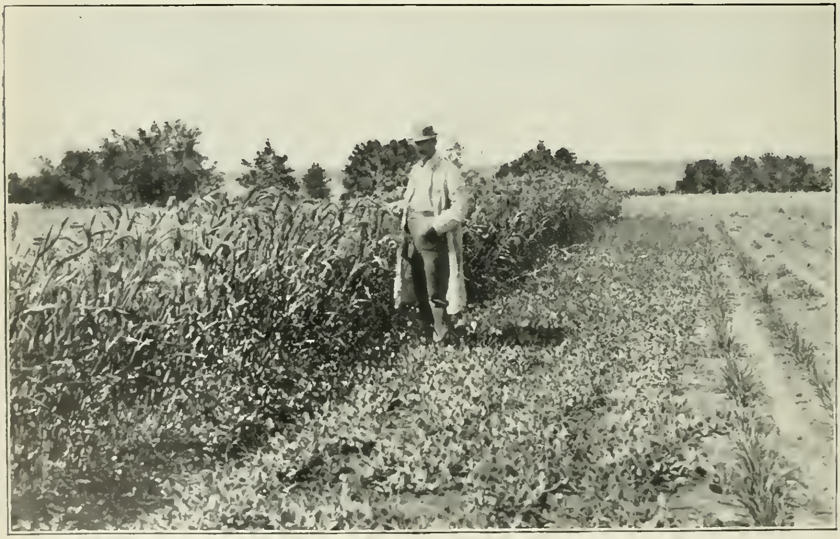


FIG. 2.—VIEW IN GRASS STATION AT WALLA WALLA, WASH., SHOWING RED LUMP MILLET ON THE LEFT AND METCALFE BEAN IN CENTER.

From a photograph by F. Lamson-Scribner, 1899.

Mr. James Lofthouse, Paradise, Cache County, Utah:

A black clay loam was plowed in the fall. The seed was sown the last of June, 1899, and raked in by hand. The crop received no cultivation, but was irrigated twice. It is at this date (November 15) about 6 inches long and nice and green. I think it will do well here and be very valuable for meadows and late pasturage.

SACCATON (Muhlenbergia distichophylla).

A rather coarse, firmly-rooted grass, 3 to 4 feet high, with long, narrow, rigid, drooping leaves and loosely flowered, somewhat narrow, panicles. It is a native of Arizona and New Mexico, where, together with *Sporobolus wrightii*, it is classed under the general name of Saccatone, which is the common term for native hay in those regions. This grass produces a large amount of dense foliage all through the dry summer weather, and might prove of considerable value if it could be introduced into cultivation. Eighteen packages of this seed have been distributed and six reports have been received. Most of those reporting have had poor success and do not consider it worth experimenting with.

JAPANESE BARNYARD MILLET (Panicum crus-galli).

(Plate VI, fig. 1.)

The seed of this variety was secured by Professor Brooks, of the Hatch Experiment Station, Massachusetts, from northern Japan, where the grain is used to a considerable extent as human food. It has been thoroughly tested and highly recommended as a forage crop by that station, and is considered superior to the "Ankee" millet because of its earliness. A crop of hay can be matured in about two and one-half months. It differs from the ordinary barnyard grass in its upright growth, finer branches or suckers, softer and lighter colored foliage, later and shorter season of ripening, compact awnless heads, and less ability to withstand drought. At the Hatch Experiment Station it has produced 67 bushels of seed, 11,297 pounds of straw, 18 tons of green fodder, or 6 tons of hay per acre. It is said to be superior to good corn fodder in feeding for milk, and in combination with soy beans makes very superior silage. Professor Brooks found by alternating the millet cut from day to day and fed green to cows with well-eared flint corn fodder, that the cows invariably increased in milk when put upon the millet and fell off when changed to the corn. From a peck to a half bushel of seed per acre, according to the richness of the land and the season of sowing, is sufficient. This millet will not endure drought well, hence the necessity of sowing early and harvesting a crop before the late, dry summer months begin.

Seventy-eight packages of Japanese barnyard millet have been distributed by this Division since 1896, 59 of which were obtained from, and grown at the Hatch Experiment Station. Most of the trials proved to be failures, owing to the lateness of planting and the severe drought. Twenty-nine reports have been received, of which 14 record failures, 5 unsatisfactory, and 10 good results. The following are some of the reports which have been received:

Mr. E. M. Graham, Ruston, Lincoln County, La.:

Two plantings were made, on the 1st and 15th of April, 1899, respectively. The soil of the first planting was sandy, thoroughly pulverized and fertilized with manure from a cow lot. The second planting was on rich bottom land without any fertilizer, but the soil was thoroughly plowed. In both cases the seed was sown in drills about 30 inches apart. I did not harvest the millet until the seeds were fully matured, which was about the 10th of July It makes good feed, cut green or cured. It grew off slowly at first, but more rapidly as its roots took to the soil. It was not a fair test, however, because of the severe dry weather in May and June and part of July. I think this millet will be a good crop for this climate, and could be sown by the 15th of March and harvested by the 15th of May. All stock relish it.

Mr. John Howat, Welton, Clinton County, Iowa:

The land used was a heavy, loam, prairie soil, underlaid with clay. It was well prepared by plowing, harrowing, and pulverizing with a disk cultivator. The seed was sown in drills, June 8, 1899. The land was cultivated twice with a corn cultivator, and the crop harvested on September 4, when ripe enough for seed. The yield is heavy, but the crop has not been thrashed yet, and its feeding value can not be estimated before winter feeding. This is without doubt a valuable variety of the barnyard millet, and will make a great crop of hay. Some of the seed which I sowed broadcast produced a crop that was laid down by a heavy storm, while that sown in drills came up again. I made an exhibit of the plants at our county fair. The stalks were 5 feet high.

Mr. Daniel McLaren, San Diego, San Diego County, Cal.:

The seed was planted in drills about the middle of April on well-prepared, heavy "adobe" soil. The millet was in full bloom about the middle of July. The millet was harvested about the middle of August when fully ripe. In quality it is good, but I could not do it full justice, as I was short of water. I am favorably impressed with its value as a forage plant, as stock is very fond of it, and it yields an abundance of seed.

Hon. H. C. Warner, Forestburg, Sanborn County, S. Dak.:

The seed was sown broadcast May 20, 1899, and harrowed in. I secured a perfect stand, but the drought of July, August, and September ruined the crop so that it failed to head. I have grown barnyard millet for three years previous to this, and it has proved very valuable for hay.

Mr. W. A. Wilkin, Salesville, Guernsey County, Ohio:

The yield per acre was about 2 tons. The quality of the hay was good, but coarse, and the growth very heavy. I believe it to be a valuable crop to help out when the hay crop is cut short by drought or other cause.

Mr. J. T. Wright, Anson, Jones County, Tex.:

The seed was sown in drills April 5, 1899. It matured a crop about June 20, and yielded about 2 tons per acre. The quality of the product is very good. This millet is a rapid grower, and, if the season permits, a second crop can be secured after the first cutting, which will double the yield. It should be harvested when in full bloom to make the best feed. I think it will be valuable, and I want to continue my experiments with it next season.

RED LUMP MILLET (Panicum miliaceum).

(Plate VI, fig. 2.)

The seed of this variety was received by the Department through Prof. N. E. Hansen, in February, 1898, from Orangeburg, Russia, on the boundary between European Russia and Siberia, where it is said to endure very severe drought. The seed is large and is much used by the peasants and Kirghiz Tartars for food. It is a variety of the common broom-corn millet of Europe, which has been in cultivation there for centuries. The branches of the panicle or head of red lump millet are shorter, more erect, denser, and closer together than the varieties of broom-corn millet commonly grown in this country. Its seeds are shiny and of a light reddish-brown color. It does not grow quite so tall as many of the other varieties, averaging only from 1 to 3 feet. It will be highly valued in the North and Northwest, owing to its ability to mature a crop of seed in a very short time. During the dry seasons, so often prevailing in those regions, it may, to some extent, serve as a substitute for corn. There is, perhaps, no other millet in this country that will produce such heavy yields of seed per acre. It seems to be well adapted to the climatic conditions of Kansas, as nearly all the experimenters in that State report having had excellent success, except for the ravages of chinch bugs and grasshoppers. In the States of Montana and Nebraska it gave very promising results, while in the Dakotas the seed is highly valued for chicken and hog feed, and sometimes as a substitute for corn in fattening cattle. It will probably never prove as valuable for hay as any of the foxtail and broom-corn millets now known in this country, because it does not produce as much leafage, and its stalks are inclined to be coarse, especially when thinly sown. In the spring of 1898, 360 5-pound packages of the seed of red lump millet were distributed by the division through the Section of Seed and Plant Introduction. One hundred and sixty-six reports have been received. The seed was distributed to volunteer experimenters in 34 different States, and reports have been received from Colorado, Kansas, Montana, Nebraska, North Dakota, Oklahoma Territory, Oregon, South Dakota, Washington, and Wyoming.

The following reports received from experimenters in the above States will testify as to its value as a forage plant for this country:

COLORADO.

Mr. E. E. T. Hazen, Holyoke, Phillips County:

A sandy, slightly gravelly loam was plowed 10 inches deep and harrowed twice. The seed was sown broadcast May 7, 1898, and the land harrowed twice after sowing. The millet was well up by May 25, and by August 1 it was thoroughly ripe. It was fully ripe in about seventy-five days from the time of sowing and fifty days from the date of its coming up. The yield per acre would probably be about 58 bushels. The straw was not very long on account of drought, but the quality of both seed and straw was good.

Mr. W. H. Wilder, Trinidad, Las Animas County:

The seed was sown broadcast in the garden about June 29, 1899. It ripened about September 1, and yielded about 25 bushels of seed per acre. The quality of the forage was good but rather coarse. The red lump millet is a good thing, but for winter feed only.

KANSAS.

Mr. S. S. Dickinson, Larned, Pawnee County:

The land was plowed 8 inches deep, then harrowed and rolled. The seed was sown broadcast May 13, 1898, and harrowed in. By July 14 it was 18 inches high on an average and well filled with seed in the milk stage. It would have averaged 3 tons of hay to the acre.

Mr. C. P. Fullington, Wichita, Sedgwick County:

A black, sandy loam was plowed, harrowed, and rolled. The seed was sown broadcast July 1, 1898. It was in full bloom about August 5 and had ripened its seed by August 20. The quality of the product was good and the yield of seed particularly heavy. It grows well and has the appearance of being a good forage plant.

Mr. C. H. Jackson, Kidderville, Hodgeman County:

The land was plowed deep and the seed sown May 12, 1898. By August it had headed well with large heads filled with an abundance of seed. The plant grew to be about 12 inches high. The seed was so heavy that it was impossible to gather it except by hand. If it had been planted thicker on the ground it would have been practicable to harvest it with a header. The seed might make good hog feed if it could be saved.

Mr. M. Mellinger, St. Francis, Cheyenne County:

A black, loamy soil was spring plowed and the seed sown broadcast May 1, 1898, and harrowed in. It was cut the 15th of July, before fully matured, on account of the danger of grasshoppers destroying it. I regard it as a valuable forage plant.

Mr. Mads. Olson, Mullinville, Kiowa County:

The soil used was old ground in good condition. The seed was sown with a press drill about the middle of May. I harvested it when fully ripe, the latter part of July. It grew very rapidly to a height of about 2 feet, producing very large seed heads. I have nearly a bushel of seed which I will sow next year on some new land. It seems to stand the dry weather better than the other millets.

MONTANA.

Mr. Marion Flaherty, Bozeman, Gallatin County:

A well-prepared sandy loam was used. The seed was sown by hand May 23, 1898, and harrowed in with a light harrow. By August 8 there was a heavy crop, well filled with good, plump seed. I want to try it for ensilage, as the season is too short for corn here. I think it will be a valuable crop for the silo. I will sow about 5 acres of it next season. If its fattening qualities are good it would be useful here as a substitute for corn for fattening cattle.

Mr. Daniel Fratt, Billings, Yellowstone County:

A sandy soil was plowed in the spring and the seed was sown about May 20, 1898, and harrowed in. Part of it was irrigated and part not. It was fully matured about September 8. The plant makes a fine growth and is well adapted to this soil and climate. It yields well, but I have not been out to my ranch since it was thrashed. This millet would be valuable for hay here when labor is cheap; but owing to its having to be sown each year, and the seed harvested and thrashed, it is not profitable in this part of the State, where labor is $35 per month.

Mr. G. M. Lewis, Meyersburg, Park County:

A stiff, rich soil was plowed deep and thoroughly disked and harrowed before sowing. The 5 pounds of seed were sown broadcast June 6, 1898, on one-fourth of an acre, and covered with a tooth harrow. It was cut for hay about September 15, when the blossoms began to fall. A strong growth 4 feet high was produced which stooled out well. Some of it was irrigated once with reservoir manure, which accelerated the growth considerably. A slight frost which affected potatoes did not affect the millet. The yield was probably from about 3½ to 4 tons per acre.

Mr. Emory Vine, Miles City, Custer County:

A sandy loam was plowed and harrowed in the usual way. The seed was sown broadcast about the last of May and harrowed in. The crop was harvested for seed about the 1st of September. It was not very good for hay, but it seems to be a good drought resister, and I am inclined to think it would be a good forage for this country where they can not irrigate.

Mr. C. C. Willis, Plains, Missoula County:

The seed was sown May 4, 1898, on dry bench land. I did not secure a very good stand. The plants grew to be about 2 feet high, and were in full bloom about July 20, the seed ripening about August 15. If I had secured a good stand I would have had 3 or 4 tons to the acre. It has large, well-filled heads, and is a fine, rich feed. I think it would be a good fat and milk producer. In 1899 the crop of red-lump millet was very rank and thrifty, stooling well with a great deal of foliage on the stalks. This year I failed to raise any seed on account of so much rain. I think it a good forage plant for this country.

NEBRASKA.

Mr. Edward Barnes, Dorchester, Saline County:

A black loam was plowed and harrowed fine. The seed was sown June 1, 1899. The millet was just going out of bloom August 15. The yield per acre was about 3 tons. It is an excellent forage for cattle and horses.

Mr. M. H. Chase, Palisade, Hitchcock County:

A black, buffalo-grass land was used. The soil was put in fine condition, and the seed was sown broadcast May 24, 1898, and harrowed in. The quality of the product was very fine. In comparison with a similar kind of millet raised here it seems to be very much better. The yield of seed was about 15 bushels per acre. I sowed it too thin in order to get more seed, and in consequence was troubled with weeds.

Mr. Alfred Shirley, Weeping Water, Cass County:

A light soil was prepared with disk harrow and the seed sown by hand May 10, 1898, and harrowed in. The millet was in full bloom by August 1, and ripe about the last of August. It makes a strong, vigorous growth far exceeding any other variety of millet grown in this section. It can be grown successfully, and in this State can not be recommended too highly.

NORTH DAKOTA.

Mr. William Brittin, Sterling, Burleigh County:

A sandy soil, which had been in cultivation for fourteen years, was spring plowed and harrowed into good condition although rather dry for seed to germinate in. Five pounds of seed were sown May 12, 1898, with a shoe drill on one-seventh of an acre. It should have been sown a little thinner. A heavy rain fell May 21 and the seed came up May 24, making a good growth until the July drought set in, which stunted the yield of straw and blasted a portion of the seed. I think the red-lump millet will do well here. The seed ripened about August 10 and yielded about 3½ bushels to the acre.

Mr. W. Hanson, Englevale, Ransom County:

A very dry, clay loam was spring plowed and well harrowed. The seed was sown broadcast May 20, 1898. I did not cut any for hay, but the seed ripened about August 15. I believe it will do well as a seed-growing crop. It appears to be a good yielder.

Mr. J. W. Higgs, Silverleaf, Dickey County:

The seed was sown broadcast May 27, 1898. The millet made a very fast growth and was in full bloom by August 11. The yield of seed was about 18 bushels per acre. In a good season it would make a large crop of both hay and seed. I think it well adapted for this country. In 1899 I planted again, but it was not a good season for any of the millets. For hay the red-lump millet is not as good as the German millet, but for grain it is better than any other variety I know of. All stock prefer it to the hog millet. I shall have enough seed next year to supply the neighborhood.

Mr. H. S. Nichols, Oakes, Dickey County:

A black, sandy loam with clay subsoil was used. The seed was sown broadcast about May 15, 1898, and harrowed in. The crop was ripe about August 1 and yielded well, though I can not give the amount. This is a good plant for forage. When ground, stock relish it, and it seems to be equally as rich as maize. I intend continuing my experiments with this plant. The estimated yield in 1899 was 20 bushels per acre. It is excellent food for all kinds of stock, and does best in this locality when sown late. Some good crops were reported when sown as late as July 4. It is valuable for both grain and hay.

OKLAHOMA TERRITORY.

Mr. A. C. Aborn, Omega, Kingfisher County:

A dark, rich loam was plowed and well harrowed. The seed was sown broadcast in May, 1898. The crop reached maturity in July. I believe it will be a good millet for this country, but it did not have a fair test on account of the wet weather. I have saved enough seed to test it again.

Mr. C. L. Boyd, Redmoon, Roger Mills County:

A red, sandy, river-bottom loam that had been in cultivation for three years was used. In 1897 it produced 4 tons of German millet per acre, which grew 6 feet high. The ground was broken in February, rebroken in April, then harrowed down fine. The seed was sown broadcast April 26, 1898, harrowed in with a light harrow, and afterwards rolled. Excessive rains in May and June produced so much overflow and standing water that it did not have a fair chance and grew only 1 foot high, 50 per cent of it being drowned out. I do not consider it of much value for forage, but as a grain feed, under more favorable circumstances, it would yield at least 50 bushels of good grain per acre.

OREGON.

Mr. E. R. Reames, Klamath Falls, Klamath County:

A sandy loam was plowed, harrowed, and well cultivated. The seed was sown broadcast April 20, 1898, and covered with a harrow. The plants bloomed August 25, and ripened seed by September 10. The quality of the product was good. Having but a small quantity of seed I could not estimate the yield per acre, but it was very heavy. It grew about 15 inches high, with very large heads containing plump seed.

Mr. J. O. Stemmler, Dora, Coos County:

Second bottom land was used. The seed was sown broadcast May 1, 1898. The millet was in full bloom by July 15, and ripened seed by September 1. The yield per acre was about 3½ or 4 tons. This millet grows very well on good land and yields all that any reasonable person should desire. Its probable value is about $3 per bushel.

SOUTH DAKOTA.

Hon. H. C. Warner, Forestburg, Sanborn County:

A sandy loam was plowed and harrowed. The seed was sown broadcast June 1, 1898, and harrowed in. The millet ripened by September 1 and produced a good quality of seed. This variety was planted along with 12 other varieties of millet and proved to be more productive of seed than any of them. It received first premium at the State fair for the best peck of millet seed. For poultry feed or for grinding for hog feed it will be best of all.

WASHINGTON.

Mr. W. E. Lawrence, Toppenish, Yakima County:

An alluvial soil was used that had the sage taken off, then plowed 10 inches deep, and harrowed. The seed was sown in drills 10 inches apart April 1, 1899. The crop was fully ripe by June 10. The yield per acre was about 4 tons of hay and 900 pounds of seed. The hay is extra good for cattle. This millet grows best on good soil, just damp enough for germination, and will not stand much irrigation. When cut green it makes excellent cattle feed. The seed is one of the best feeds for poultry and sells readily at 10 cents per pound.

WYOMING.

Mr. W. R. Williams, Ten Sleep, Bighorn County:

A sandy loam was plowed and put into good condition. The seed was sown broadcast May 12, 1898, and harrowed in. The crop was irrigated once. It was very ripe by August 10. The quality of the product is very good. I consider this one of our best crops for hogs and chickens. I raised 6 bushels of seed from the 5 pounds sent me. My neighbors all like it, and I have given away 2 bushels of seed in small quantities.

FOXTAIL MILLETS (Chætochloa italica and var. germanica).[1]

(Plate VII, fig. 2.)

The foxtail millets are by far the most important group of millets grown in this country. They have a compact, bristly, foxtail-like head and are said to have evolutionized from the common foxtail grasses of the fields and waste places. To this group belong the common, German, and Hungarian millets with their many-named forms and varieties.

"The common millet is the most widely cultivated of the foxtail millets in this country at the present time. It is the hardiest, most drought-resistant, and gives better returns on poor soils than the other commonly grown varieties. Although long known in Europe, it seems to have reached its perfection in this country, and is now being sold in Europe under such names as American millet and California millet."

"The German millet makes a heavy yield of forage under favorable conditions, but does not stand drought as well as the common and Hungarian millets. The hay is coarser and less highly valued than that from the other millets, but when the forage can be fed in the green state this will be found to be an excellent variety to grow on account of the heavy yield. Some of the so-called Japanese millets now on the market belong to the German millet type."

"The Hungarian millet or grass has been in cultivation in the United States since 1830, and probably much earlier. It first came into general cultivation in the Middle West. In Iowa it won favor at once, and as early as 1856 was a most valuable forage crop, particularly on recently broken land. At the present time it is more widely grown in the North than in the South. By most farmers it is placed next to the common millet as a hay crop, the quality being regarded as better than German millet.

"Hungarian millet does not resist drought as well as common millet, but with favorable conditions of soil and moisture it will usually give a somewhat heavier yield. One reason why Hungarian has not found more favor with farmers generally is that it shows a greater tendency than other common varieties to persist in the soil when allowed to mature seed before harvesting. In portions of the Missouri Valley region, as in eastern Nebraska and Iowa, this millet received a great deal of attention from farmers during the seventies, and fine crops of hay and seed were obtained, but its tendency to 'volunteer' brought it into more or less disfavor, and it is now less commonly grown than either common millet or German millet. It seldom becomes troublesome, however, except on light, sandy soils or land recently brought into cultivation. On moist, heavy soils or in regions where there is a great deal of wet weather during the fall and winter months it is not likely to make much volunteer growth."

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[1] For full discussion on "Millets," see Farmers' Bulletin No. 101, United States Department of Agriculture.

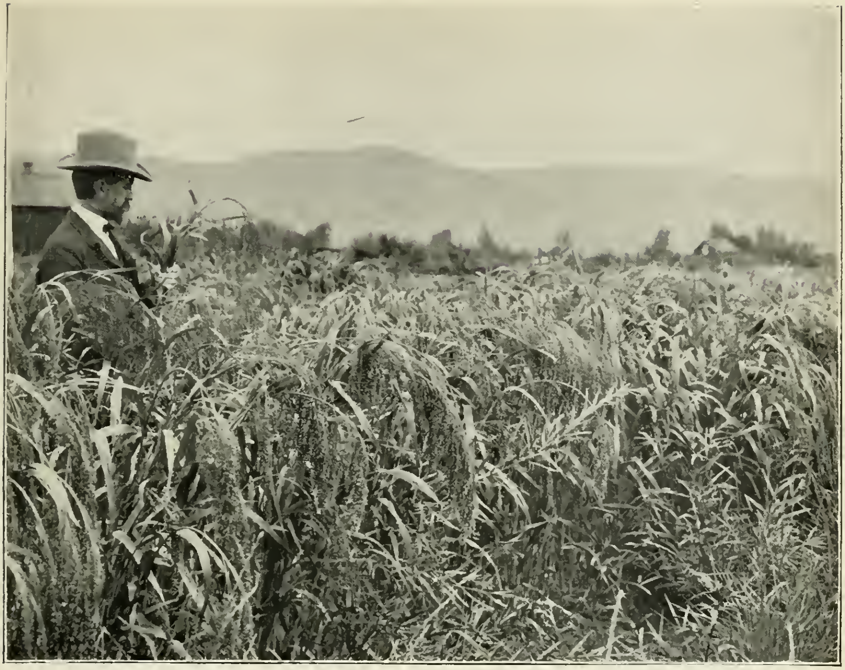

FIG 1.—BROOM-CORN MILLET GROWN AT NORTH YAKIMA, WASH.

From a photograph by A. B. Leckenby, 1899.

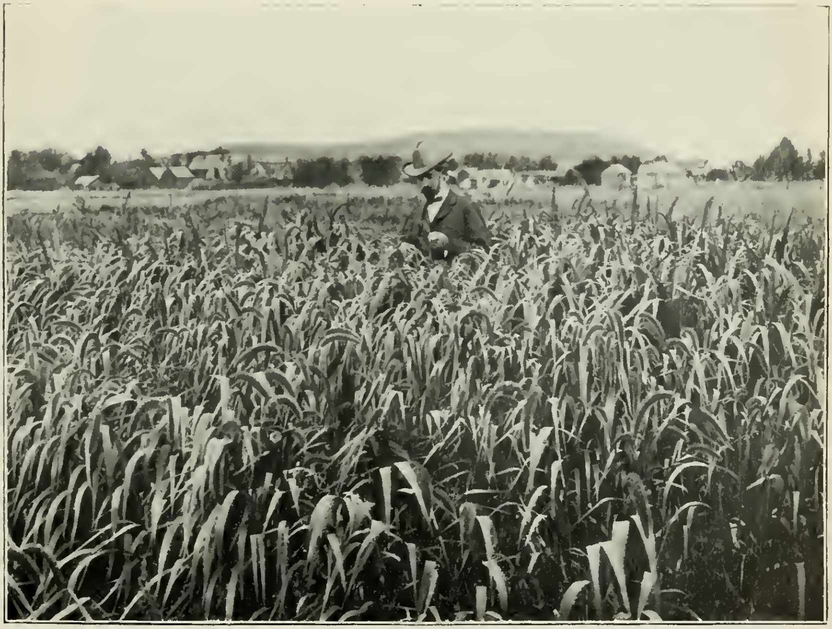

FIG. 2.—MILLET, FROM A VIEW IN GRASS STATION AT NORTH YAKIMA, WASH.

From a photograph by A. B. Leckenby, 1899.

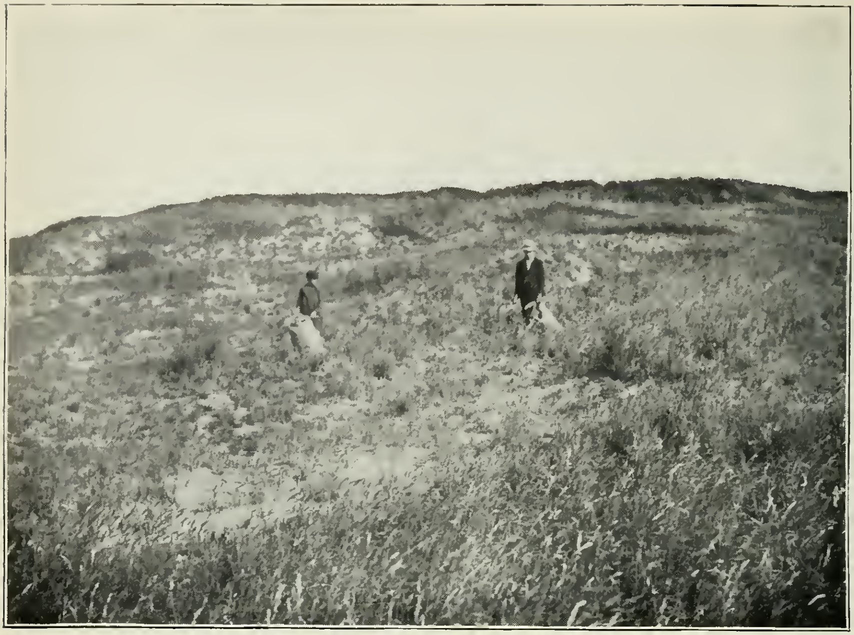

FIG. 1.—COLLECTING SEED FOR UNITED STATES DEPARTMENT OF AGRICULTURE, DIVISION OF AGROSTOLOGY, OF SEASIDE BLUE GRASS NEAR MORRISON, OREG.

From a photograph by A. B. Leckenby, 1899.

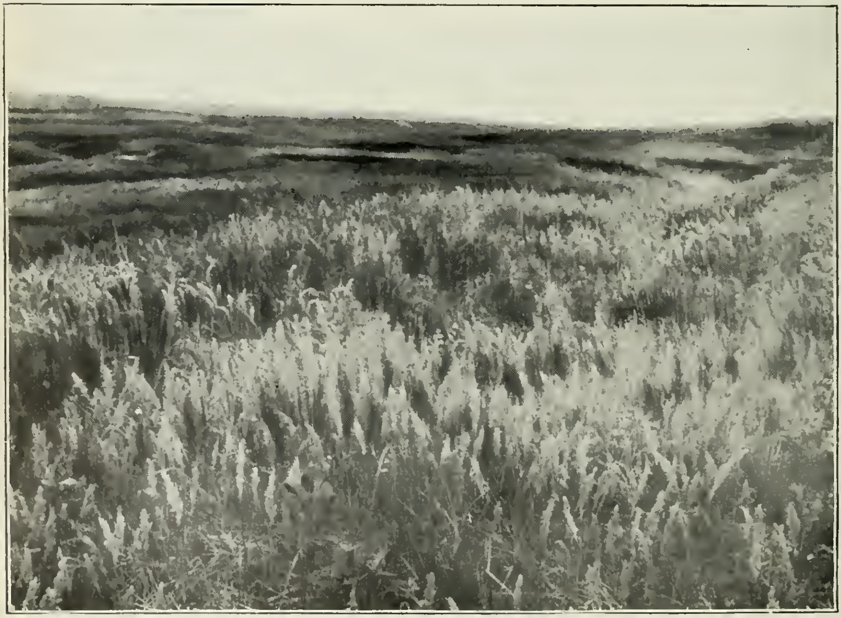

FIG. 2.—SEASIDE OR ASTORIA BLUE GRASS (POA MACRANTHA).

From photograph taken near Morrison, Oreg., by A. B. Leckenby, 1899.

Since 1896 thirty-one packages of different forms and varieties of foxtail millets have been distributed by this division, and 12 satisfactory reports have been received.

The following report from Mr. C. E. Kittinger, of Powell, S. Dak., is of much interest to the farmers of that region:

> Next to the grasses were sown the following kinds of millets: Japanese Foxtail millet (*Chætochloa italica*), Japanese barnyard millet (*Panicum crus-galli*), Red Japanese Broom-corn millet (*Panicum miliaceum*), Early Harvest, Golden Wonder, Buckbee's California Beauty, Manitoba, common, and Hungarian millets.
>
> All of the Japanese millets grew tall and coarse, and were late in maturing, especially the first two varieties. The stalks grew nearly 4 feet high, as large as lead pencils, and when ripe were about as woody. The heads were erect and very compact. The red Japanese was the first one to ripen and the worst to shell out of the three varieties. In growth it resembles broom-corn millet. Early harvest grew much like common millet, and was the first of all to mature. Golden wonder grew larger than any other variety, with coarse, woody stems. It was late in ripening and lodged badly before mature. It had a large amount of leaves on the stem, and on poorer ground or with less rain might have made good hay if cut early. Buckbee's California beauty grew large and coarse, with long, drooping heads of large seed, but was later than common millet. Manitoba millet grew much like broom-corn millet and shelled badly. Hungarian grass is much like common millet, but has a more leafy stem, and the seeds are brown instead of yellow. Most of these grew larger than common millet and were later in maturing. Under different conditions, they would no doubt have been smaller, but taking all things into consideration, none of the varieties tested promise greater usefulness than the common millet.
>
> Millet is one of the best forage plants that can be grown in this section, but when intended for hay ought to be cut before the seed is ripe. It is much harder to cure than prairie hay, and it ought to lay in the windrows or bunches until thoroughly dried, or it will heat and mold in the stack, while if left to thoroughly cure before raking up it will bleach badly, and bleaching spoils its nutrition. Hay ought to be cured without being exposed to direct sunshine, but that is not possible to do on a large scale. It can be raked green and allowed to dry in the windrow, so that only a small part of it will be exposed. The old adage, "Make hay while the sun shines," should be revised to read, "Make hay while the wind blows."

SEASIDE BLUE GRASS (Poa macrantha.)

(Plate VIII, figs. 1 and 2, and Plate XIII, fig 2.)

A smooth, stout grass 1 to 2 feet high, with strongly creeping rootstocks, dense, erect panicles, and very large spikelets. It is found growing abundantly on the sand dunes along the Pacific coast, where it is highly valued for its sand-binding qualities. At the grass station at Walla Walla, Wash., it has given excellent results, showing but little the effects of frost, and promises to be of great value for forage. Experiments which have been carried on by sowing the seed on the sands bordering the Great Lakes indicate that it may prove valuable as a sand binder, not only along the seacoast, but also in the sandy regions of the interior.

Eighteen packages of seaside blue-grass seed collected by special agents on the Pacific coast (see Plate VIII, fig. 1) were distributed by this division during the fiscal year 1898-99.

Only 4 reports have been received from experimenters along the Atlantic coast. In 2 cases the seeds failed to germinate and the others secured a fair stand of plants from 6 inches to 1 foot high. Further experimentation is necessary before we will be able to state the value of this grass to the Atlantic coast and the lake regions of the interior.

MISCELLANEOUS FORAGE PLANTS.

DWARF ESSEX RAPE (Brassica napus).[1]

(Plate IX, figs. 1 and 2.)

A succulent, nutritious biennial forage plant with large, glaucous, smooth, spreading leaves, which has been widely cultivated in the northern United States and Canada. Its area of usefulness, however, might be made to extend more largely to the West and Northwest, as there are many places it may occupy in the rotation of crops on the farm. By the use of irrigation excellent crops of rape can be grown in the semiarid regions, and recent reports indicate that it will withstand quite severe drought if well cultivated. It makes an excellent feed for fattening sheep and is a valuable food for young lambs at weaning time. Rape will endure quite severe cold weather, and sheep can be pastured on it late into the winter, until the snow covers it up. Animals should not be turned into the rape pastures when the leaves are wet, for fear of bloating, and they have been found to do better when they have access to an open grass pasture as well as to the rape. There are several varieties of rape, but the Dwarf Essex is the most widely cultivated. Under average conditions a yield of from 10 to 20 tons or more per acre may be expected, although much heavier yields have been recorded. Mr. W. H. Heideman, of Kalispell, Flathead County, Mont., has had wonderful success with this plant for several years. He regards it as one of the greatest forage plants known. He cut it three times the first season for feed, and the second season secured a fine yield of first-class seed. The illustration (Plate IX, fig. 1) represents a single plant grown by him from his own seed.

Sixty-one small packages of the seed of this variety were distributed in the spring of 1899, but so far only 12 reports have been received from the experimenters, with 2 failures, 2 unsatisfactory, 2 good, and 6 excellent reports.

The following are some of the reports received from different States:

Mr. Thomas Ashcroft, Ashcroft, Harding County, S. Dak.:

> The seed was sown broadcast in June as soon as the land could be plowed, and then harrowed down before it dried hard. The land was not cultivated in any way

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[1] For full discussion of "Rape as a forage plant" see Circular No. 12, Division of Agrostology, U. S. Department of Agriculture, Washington, D. C.

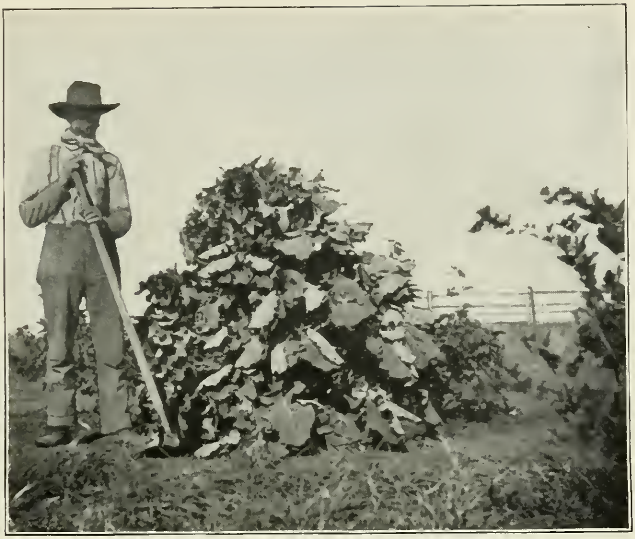

FIG. 1.—A SINGLE PLANT OF DWARF ESSEX RAPE, GROWN BY MR. W. H. HEIDEMAN, KALISPELL, MONT.

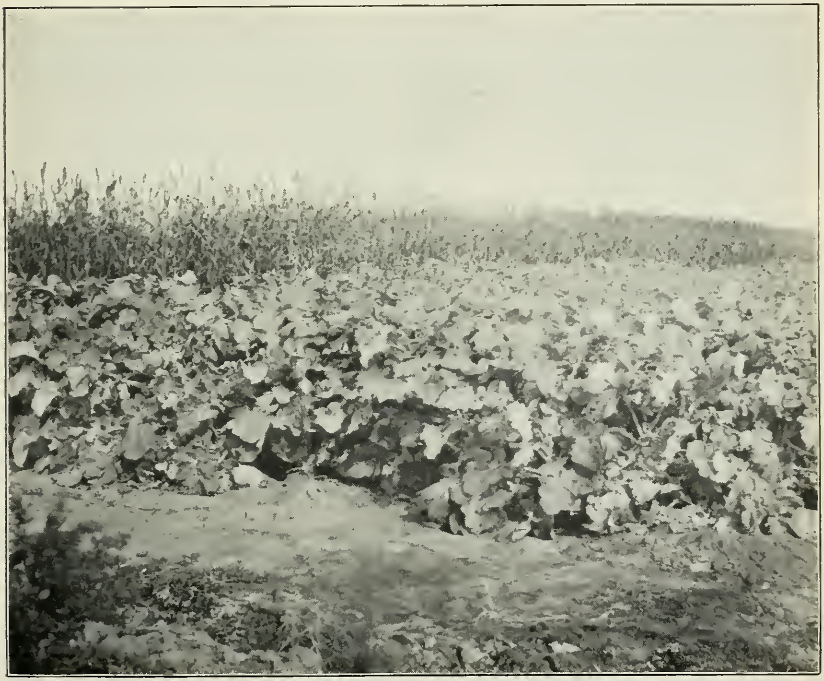

FIG. 2—RAPE GROWN AT MELLETTE, S. DAK.

after sowing. The rape grew to perfection, and I am still cutting it (November 10) and have been for six weeks feeding it to our milch cows. It does not affect the butter and is an excellent plant to bring them home before sunset. It is quite green yet and will not ripen. If weighed as soon as cut, I should judge it would give about 20 tons to the acre. Its value is incalculable. We began to give it to calves in the pen as soon as the commencement of hay time. Everything appears to like it. Cows eat it with avidity. It is quite the wonder of the neighborhood. I have been asked more than forty times, "What is that green stuff down there?"

Mr. Will Crosier, St Edward, Boone County, Nebr.:

The seed was sown broadcast May 30 on a well-prepared black loamy soil. It kept growing until fall, and I think it would make an excellent forage plant for pasturage.

Mr. J. E. Krasomil, Atlanta, Phelps County, Nebr.:

The seed was sown broadcast April 10 on a well-prepared moist, rich, black, loamy soil. It did splendidly, but I did not do anything with it. It now stands 14 inches high, and the frost has no affect on it.

Mr. J. B. Nixon, Charleston, Franklin County, Ark.:

A rich common prairie soil was used. The seed was sown in drills May 3. It was well cultivated to keep the ground mellow and free from weeds and grass. The quality of the product was good and the growth rapid. The leaves are large and succulent and greatly relished by cattle and hogs. I consider it will be a most useful green fodder and forage plant.

SULLA (Hedysarum coronarium).

A strongly rooted, vigorous, perennial legume with numerous very succulent, radical, compound leaves, varying in height from 1 to 6 feet, according to soil and climatic conditions. It is a native of southern Italy and was first introduced into cultivation in 1766. For the warmer sections of the United States, subject to long-protracted drought, sulla may prove a most valuable forage plant, and is worthy of extensive trials in Texas, Florida, and other Gulf States. It will withstand slight frosts, but is killed if the roots are frozen. The practice is to sow the seeds in September or October on land that has been deeply plowed and thoroughly pulverized, either alone or with winter wheat or oats. In feeding value it compares very favorably with red clover and alfalfa. It is best adapted to tropical and subtropical climates.

Our special agent at Abilene, Tex., reports having had very fair success with it. The seed was sown May 4. It grew vigorously from the start, and by the time the hot and dry winds began, early in July, it had reached a growth of from 6 to 12 inches. The long four months' drought, however, caused the leaves to wither and die, but the roots held their own and continued to grow down into the earth. On the approach of rain in the fall the plat was soon green again. He believes that it is going to prove of much value and that it should be tested in all sections of Texas.

Twenty-nine packages of the seed of sulla were distributed in 1898 and 10 reports have been received, only a few of which are satisfactory.

Mr. O. S. Herrington, Dollie, Jones County, Miss., reports:

> A sandy, pine ridge in first-class condition was prepared as for cotton. The seed was sown broadcast. On account of dry weather I failed to get a stand until December 1. There is no doubt but that sulla will do well here. I scattered some seed on unprepared land, and it came up with the first rains, and now looks as thrifty as that on the prepared land. I shall be glad to report again later on.

TURKESTAN ALFALFA (Medicago sativa var. turkestanica).

(Plate X, fig. 1.)

This variety of alfalfa was received for the Department, through Prof. N. E. Hansen, from eight localities in Russian Turkestan, in June, 1898. It is found growing from the cotton-growing sections of Bokhara and other parts of Russian Turkestan, into western China and to its northern limits near Kopal, Siberia.

Prince Massalski, of the Department of Agriculture at St. Petersburg, writes (The Industries of Russia, Vol. III, p. 459):

> Lucern-clover (*Medicago sativa var. turkestanica*) is the chief forage in use throughout Central Asia, and to the settled population of Turkestan is of the highest importance, since during the summer it forms the chief, and in winter, prepared in the shape of hay, the only fodder for cattle. It is of all the greater importance because within the region populated by settled inhabitants there are no meadows. Soft herbs and other grasses that grow up in the early spring in certain parts of the steppes are quickly dried up by the hot rays of the sun, and give place to coarse, prickly stubble, or in any case to less nutritive grasses that are in general unfitted for sheep, camels, or steppe cattle, and still less fitted for horses or the cattle of those who are settled in the oases, and are thus closely confined to the forelands or rivers, and in most cases are far removed from the steppes.

Prince Massalski describes the native methods of cultivation and irrigation, and continues:

> The native lucern would seem to be a cattle fodder that can not be replaced in countries so dry and so hot as Turkestan and the Transcaspian Province. Parallel experiments that have been made in the Merv oases, in the Transcaspian Province, in sowing native and French lucern, particularly where there is a lack of water, show that it is vastly superior to the French in the crops it yields, and that it is able to grow satisfactorily with a minimum supply of water, a supply so small that European lucern would perish from drought. This peculiarity of the native lucern is to be explained by its peculiar structure. It possesses a very large root system, and its leaves are covered with thick down; this, in conjunction with a deep-cut channel on the leaf, enables the plant on the one hand to imbibe the moisture from the deeper layers of the soil, and on the other hand to exhale it in very small quantity.

Alfalfa is extensively grown throughout the entire United States with the exception of New England. It is a deep feeder. The taproot descends to a great depth wherever the soil is loose and permeable,

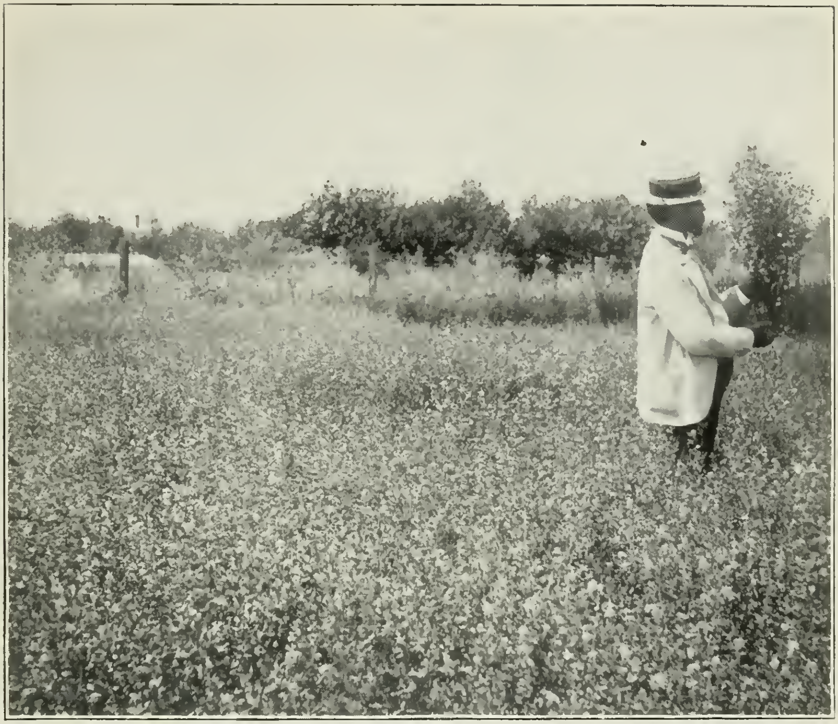

FIG. 1.—TURKESTAN ALFALFA GROWN AT NORTH YAKIMA, WASH., 1898.

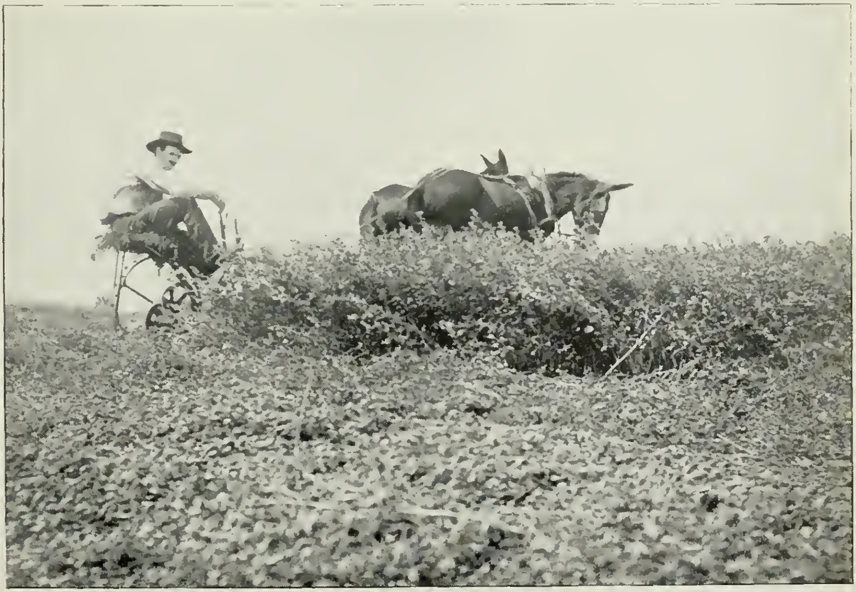

FIG. 2.—ALFALFA, BELLEFOURCHE, S. DAK., 1897.

often averaging 10 to 15 feet, while extraordinary depths of 50 to 60 feet have been recorded. The feeding value of alfalfa is very high, provided the crop is cut in due season. When cut in time and properly cured, alfalfa hay is an exceedingly valuable item in the farm economy. Wherever the soil and climate are adapted to it, a field of alfalfa should be on every man's farm.

In 1898 and 1899 three hundred and twenty-three packages of Turkestan alfalfa, of 10 pounds each were distributed by this Division through the Section of Seed and Plant Introduction.[1] This distribution included experimenters in 35 different States. Up to the present time 148 reports have been received, and already the general opinion seems to be that it is a better drought-resister than the French and Chilian alfalfas. Many, however, are inclined to believe that it is no better than the common alfalfa growing in their particular section. Others again failed to get a stand. In many instances this has been caused by experimenters not keeping the weeds down the first year. Care must be given until the young plants get a good hold on the ground.

It is not advisable to try to grow a crop of seed the first year, especially in sections of the country that suffer from severe drought and where irrigation can not be carried on. The energies of the plant are all required to produce a strong and deep root system. It will be found that if the first year's growth is cut down just previous to the long, dry, summer months, that the roots will grow much deeper down into the soil, where, during the period of drought, they will be more likely to find sufficient moisture.

In the grass garden of the Department of Agriculture, Washington, D. C., the Turkestan alfalfa grew two feet high and very rank and thrifty. Three crops were produced which were fully equal to the native varieties from different States growing alongside of it. The height, amount of growth, and quality of the hay of the Turkestan alfalfa seem to be about the same as the French alfalfa.

Experiments have not been carried on for a sufficient number of years to enable us to state its future in this country. The present indications are that it will be of considerable value to the farmers in the semiarid regions of the West where irrigation can not be carried on.

The following are a few of the reports that have been received by this Division. The majority of experimenters do not care to come to any conclusion until they have tested it for a longer period.

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[1] A total of 1,111 packages of Turkestan alfalfa have been distributed by the Department and 438 reports have been received from the experimenters. The detailed results from the entire distribution will soon be published separately.

COLORADO.

Mr. Adolph Froelich, Aroya, Cheyenne County:

A sandy loam, broken last year, was plowed about six inches deep this spring. The seed was sown broadcast May 9, 1899, when the ground was very dry, and harrowed in. We had less than the usual amount of rain; in fact, the driest season in eighteen years. The alfalfa began to bloom August 1, and I cut it with a scythe and left it on the ground. It soon grew up again 18 inches high. I irrigated part of it, first when sown and again the 8th of August. That irrigated made a fine stand, but that not irrigated was a total failure, only 25 plants coming in a plat 150 by 10 feet. It held its own better after it came up than our common alfalfa would have done; that is, where a good stand was first obtained by irrigation.

GEORGIA.

Mr. E. J. Hartman, Orr, Gilmer County:

The soil was well prepared and the seed sown broadcast about the end of May and lightly harrowed. The alfalfa gave two good cuttings of excellent quality. It has done wonderfully well on our soil. I have a fine stand now, and I hope to get fine crops next year.

INDIANA.

Miss Kate A. Drake, Elkhart, Elkhart County:

A poor, sandy soil was plowed and dragged. The seed was sown in the fall of 1898 after a rain. It came up nicely and grew well. We had a very severe winter and some of the alfalfa froze out, but a large part of it came on again in the spring. This grew finely, some of it reaching 18 inches in height. The severe drought caused it to dry up, but did not kill it, as part of it has come up this fall (1899) and looks very fine. I would like to send you a report next summer, after I see if it dries up again. I believe it would be adapted to our soil and be a valuable acquisition.

Mr. M. F. Eastman, North Vernon, Jennings County:

A clay loam was well prepared and the seed sown broadcast in March, 1899. The plat, 10 by 200 feet, has been cut three times this season, which has been a very dry one. The yield was very heavy at each cutting, averaging at least 2 tons per acre. I believe it to be a paying crop if a catch can be secured, but owing to its slow growth it is hard to get a stand.

KANSAS.

Mr. A. Y. Bentley, Wallace, Wallace County:

A good sandy loam that had been in cultivation for several years was used. The seed was sown May 12, 1898, and we had rain on the 13th and 14th. I mowed the field when the alfalfa was about 7 inches high and left it on the ground. The grasshoppers kept the plants eaten down to the crown. It came up again and is a good stand now. I sowed several patches of lucern in the spring and the grasshoppers took them all, just as they did the Turkestan, which is the only patch that survived.

Mr. Ben Brown, Natoma, Osborne County:

A rich, light, prairie soil was plowed and harrowed twice. One pound of seed was sown on an acre about May 27, 1898. A good stand was up by June 3. The plants grew well until checked by drought in July and August, but were not seriously injured.

Since the heavy rains of September 8 to 14 the alfalfa has grown from 8 to 10 inches high and is green now. It looks promising for further crops. I have 80 acres of common alfalfa which I cut 4 times each season, getting from 4 to 6 tons to the acre. This does not give a full crop until the third or fourth year. If the Turkestan alfalfa beats this it will do well.

Mr. H. C. Hollowell, Barnes, Washington County:

A dry, black loam was plowed early and harrowed. The seed was sown broadcast about May 20, 1898, and harrowed in. The growth was short, but it stood the dry weather well. I think it better than our common alfalfa.

Mr. C. H. Jackson, Kidderville, Hodgeman County:

The seed was sown May 12, 1898. The alfalfa grew about 6 inches high by the first frost. The dry weather tested it severely, but it would green up now if we had a little rain. This is the only variety of alfalfa that seems to offer a chance for successful cultivation in this part of the State.

Mr. Mads Olson, Mullinville, Kiowa County:

The soil was second sod, in good condition. The seed was drilled in the last day of May, 1898. It came up as pretty as anything I ever saw, and was nicely in bloom when the grasshoppers came and destroyed it.

Messrs. William B. Sutton & Sons, Russell, Russell County:

A new piece of black loam was broken and finely cut up with a disk. The seed was sown broadcast about May 1. The season was very dry, but we obtained a fine stand 8 inches high. It withstood the drought well and is growing quite nicely. This has been a poor season to test it; even 4-year old alfalfa made only one small cutting. There was no rain in June, July, or August.

MONTANA.

Messrs. W. W. Gamble & Sons, Choteau, Teton County:

A gravelly loam on bench land was well plowed and harrowed. The seed was sown broadcast May 19, 1898, with a hand seeder. No cultivation was given except irrigation. The alfalfa was in full bloom in July and ripened in August. The quality of the product was good. This seems to be a better plant in its growth than the ordinary alfalfa. The winter of 1898–99 seemed quite trying on alfalfa, with a tendency to winterkill. In the spring of 1899 our ordinary alfalfa came up bunchy in appearance, and although it recovered itself later in the season, the growth was irregular. The Turkestan alfalfa, however, grew even and uniform throughout the season under precisely the same conditions. It is probably a better variety than the ordinary alfalfa grown here.

Mr. W. H. Heideman, Kalispell, Flathead County:

The soil was very light, sandy, and open, varying to a black sandy loam. The land was plowed thoroughly, harrowed, then rolled and harrowed again. The seed was sown broadcast, then smoothed with a harrow and rolled again. The plants came up May 18, and were in full bloom by July 28. The crop was cut with a mower along with the weeds. So far as the experiment has gone it is very good. I think it has done remarkably well for the first year. The weather has been very hot and dry, with no rain since June, and the drought seemed to affect it but little. It was 14 inches high on July 28, 1898. The winter of 1898–99 was very severe, but none of the alfalfa was winterkilled. The year 1899 was very dry in the fore part of the season, but a great deal of rain has fallen since August 1. The plat of Turkestan alfalfa still continues to do well. It was fed down by hogs till May 28, and then let grow for seed. It made a great growth, but did not fill very well, the cold weather probably having something to do with it. After cutting, it grew up again rapidly. I think it is going to be more valuable than the common alfalfa. It seems to do well on alkali spots. I would advise all to sow it as soon as they can secure seed.

Mr. Len. Lewis, Lewis, Meagher County:

Dry limestone bench land was used. A good strong growth was secured. It seems to be hardier than the ordinary alfalfa. I think it is a valuable acquisition.

Mr. Emory Vine, Miles City, Custer County:

The Turkestan alfalfa wintered well, and is coming on this spring as if it meant business. At the present time it has a decided advantage over our common French alfalfa. It shows green several rods away, while our common alfalfa that was sown last season has not started to green yet.

NEBRASKA.

Mr. J. A. Anderson, Harrison, Sioux County:

A sandy soil in good condition was thoroughly prepared and irrigated. The seed was sown with oats May 15, 1898. The quality of the product was good, and I think it will make a valuable forage plant in this section. It did better than the common alfalfa.

Mr. J. W. Williams, Weeping Water, Cass County:

A fine black loam was plowed and harrowed. The seed was sown broadcast May 25, 1898. The plants made a very good growth and withstood our short drought very well, and are doing fine now. This variety did much better than our common alfalfa for the first year.

NEW MEXICO.

Mr. J. A. Gishwiller, Roswell, Chaves County:

A good clay loam was plowed three times and harrowed fine. The seed was sown broadcast July 13, 1898, and covered with a harrow. I secured a good stand. The growth was strong and vigorous and somewhat better than our common alfalfa sown on adjoining land. It will take another season to compare it with other alfalfa.

OKLAHOMA.

Mr. C. L. Boyd, Redmoon, Roger Mills County:

A black, sandy bottom soil was broken early in February and rebroken at the time of seeding and harrowed down fine. The seed was sown broadcast May 5, 1898, then harrowed and rolled. The quality of the Turkestan alfalfa was the finest I ever saw. I sowed alongside of it a plat of the common alfalfa and there was a marked difference between it and the Turkestan, the latter growing much ranker. I think the Turkestan the most valuable variety of alfalfa.

Mr. W. A. Rowan, Gallienas, Beaver County:

A sandy soil was plowed, well pulverized, and put into fine condition. The seed was sown broadcast May 9, 1898, and harrowed in. It was irrigated May 25, and again June 20. I secured a good stand, but it does not mature sufficiently the first year to make a good crop. It was sown by the side of some common alfalfa and given the same care. The Turkestan variety seems to be the stronger and hardier. The value of a good stand would be about $30 per acre here.

OREGON.

Mr. W. A. Wintermeier, Silvies, Harney County:

A decayed lava and clay soil was used. The alfalfa came up very nicely and even. When about 3 inches high a severe frost cut it down. It grew up again, however, but was a second time cut down by frost, but still it grew to be 1 foot high. Apparently it will not stand frost as well as the French alfalfa, but seems to be better adapted to dry soils. Another year will determine what it will do in this part of the country.

SOUTH DAKOTA.

Mr. W. H. H. Phillips, Brookings, Brookings County:

A black loam with a clay subsoil was well harrowed and made fine. The seed was sown broadcast about May 20, 1898. In March, 1899, it was covered with barnyard manure. On May 17, 1899, it froze somewhat, which gave the weeds a start. I mowed it early in July. Since then it has made a good growth. The first year it made but little growth, but now (October, 1899) it is very promising.

Hon. H. C. Warner, Forestburg, Sanborn County:

A black sandy loam was plowed deep in the spring and well prepared by harrowing. The seed was sown broadcast April 24, 1898, and harrowed in. The stand was perfect, and notwithstanding the drought and a cold, open winter, without snow, the plants came through in perfect condition. The Turkestan alfalfa was not cut this season, judging that it is better to let alfalfa become well established first. Every root of common alfalfa growing by the side of it was killed.

TEXAS.

Mr. J. W. Cartwright, Amarillo, Potter County:

The seed was sown the latter part of September, 1899. It came up nicely and now looks fine, with 4 inches of snow on the ground. I am quite proud of this, and will report later on.

Mr. Arnott West, Brownwood, Brown County:

A rich, deep, black, slightly ashy soil was used. The quality of the product was good, and altogether, throughout the season, amounted to from 8 to 10 tons per acre. This variety stands the dry weather splendidly in this part of the country if it has a deep, well-drained soil. Alfalfa should be grown here exclusively. I am feeding 200 steers on it and they are getting fat.

UTAH.

Mr. James Lofthouse, Paradise, Cache County:

The seed was sown broadcast May 28, 1898, on a clay loam. The plants bloomed July 25, but were destroyed by stock before ripening seed. This variety will stand drought better than the kind of alfalfa commonly grown here. It grew 18 inches high, and where it got enough moisture it outgrew the common alfalfa under similar conditions.

Mr. Samuel Roskelley, Logan, Cache County:

A dry sagebrush upland that had been cultivated in wheat for three years was well plowed and harrowed. The seed was sown broadcast May 9, 1898, and harrowed in lightly. I consider this one of the best and most valuable fodders for dry farms which are not irrigated in this western country. I have raised common lucern for twenty years, but for drought resistance I think this is better. My experience is that seed should not be raised from the first year's growth as by cutting before maturity it tends to send the roots down to find moisture.

OASIS ALFALFA (Medicago sativa).

This is a variety of alfalfa the seed of which was obtained from the director of agriculture and commerce of Tunis. It promises to be of considerable value in dry districts where irrigation can not be carried on. In the grass garden of the Department at Washington, D. C., this variety made a very fair growth last summer. It grew to be about two feet high and was in full bloom about the middle of July, but it produced very little seed. During the dry summer weather it still remained green, while the other alfalfas, which represented seed of 12 different varieties from different parts of the United States and from other countries, were suffering from drought and their leaves turning yellow. It can be distinguished from the other alfalfas by its somewhat differently shaped leaves, which are larger and of a lighter green color.

Our special agent at Abilene, Tex., Mr. H. L. Bentley, reports having had excellent success with this variety during an unprecedented season of drought. He secured an excellent stand, and the growth was vigorous from the start, but the dry months of July, August, and September caused the foliage to wither, and even the roots appeared dead. A rainfall on October 26, however, quickly revived them, and by November 15 a new growth of from 8 to 12 inches in height appeared, and by December 1 it had attained a growth of from 12 to 20 inches, looking as in the spring. With a normal rainfall he is satisfied that this variety of alfalfa will do well in his section without irrigation.

Twenty-four packages of the seed of oasis alfalfa were distributed in the spring of 1899, but up to the present time only 6 reports have been received. The following testimonies regarding it are not very satisfactory, as they do not represent its power to endure cold weather.

Mr. W. Atlee Burpee & Co., Doylestown, Bucks County, Pa.:

A fine stand was secured and a growth of about 10 inches. Its leaves are more like those of the common white Dutch clover, being much larger and of a light-green color.

Mr. W. W. Gamble, Chotian, Teton County, Mont.:

This variety seemed to do very well the first year, but I can not determine its value until next year. The seed was sown broadcast and the land irrigated.

Mr. E. E. T. Hazen, Holyoke, Phillips County, Colo.:

A well-prepared sandy loam that had been in cultivation for 4 years was used. The seed was sown broadcast about April 22. It germinated quickly and attained a height of about 4 inches, but an epidemic of Russian thistle struck us and sapped the moisture from the soil, and this, together with dry weather from August to October, killed the oasis alfalfa.

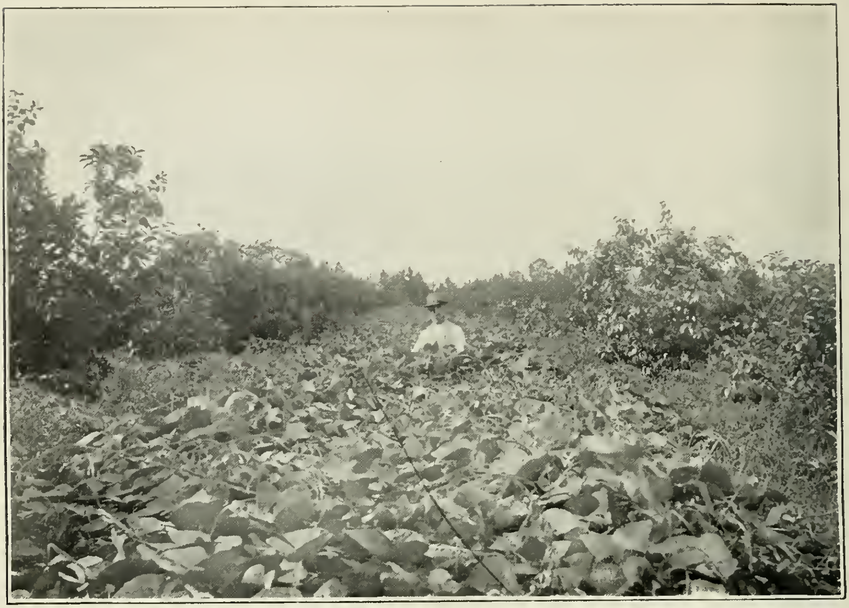

FIG. 1.—VELVET BEAN IN AN ORANGE GROVE NEAR EARLETON, FLA. SEED SOWN IN DRILLS 5 FEET APART.

From photograph, August, 1898.

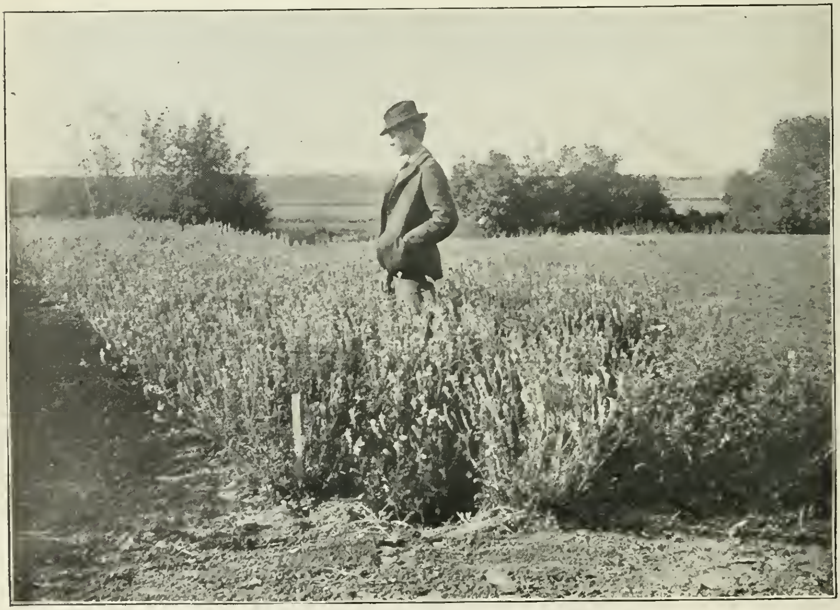

FIG. 2.—SAINFOIN; ESPARSETTE (ONOBRYCHIS SATIVA).

Hon. H. C. Warner, Forestburg, Sanborn County, S. Dak.:

The stand is perfect, but, as it is a perennial, its value can not be determined until another year.

BUR CLOVER (Medicago maculata).

An annual legume introduced from the Old World and now extensively grown in the Eastern and Southern States, and west to Texas and California. Its principal value is for winter and early spring pastures, and when once stock have acquired a taste for the burs which it produces they soon fatten on them. It is worthless for summer use and of little value for hay. The seed should be sown in October on rich, loamy soil and the plants will make good grazing by February or March. It matures in April and May, after which the ground may be plowed and cultivated in other crops during the summer. In the South it has been found very valuable to use in conjunction with Bermuda grass, as it matures its seed and dies at about the time the Bermuda grass starts into growth. Twenty-nine packages of bur clover seed were distributed during the fiscal year 1898-99, but so far only seven reports have been received. These show three failures, two unsatisfactory results, and two report it valuable as a forage crop. The following reports indicate to some extent the results obtained.

Mr. Alex. Raff, Orange Grove, Jackson County, Miss.:

A rich, sandy loam was used. The seed was sown broadcast about the end of April and covered 2 inches deep. Soon after it came up an extraordinary dry spell set in, and the clover gradually perished. I planted only one-half of the seed sent me, and will try again this winter with what is left. I believe the bur clover to be valuable for this climate, but think it should be planted in the fall or winter, as the summer sun is too much for the young plants.

Mr. E. M. Redwine, Newman, Coweta County, Ga.:

The seed was sown broadcast on well-prepared soil October 3, 1899, and harrowed in. It is now (December, 1899) up well and looks very promising.

A very similar and closely related plant, known as the California bur clover (*Medicago denticulata*), is proving to be very valuable in some parts of California. Although not so nutritious and palatable as either alfalfa or clover, it produces fine summer pasturage when other more important forage plants have become dried up by the summer heat. As the burs which it produces are prickly, they become entangled in the wool of sheep and thus decrease its value to a considerable extent.

VELVET BEAN (Mucuna utilis).[1]

(Plate XI, fig. 1.)

The velvet bean is a native of India and has been known in the West Indies and the tropics of South America as an ornamental garden plant for a great many years. It is believed to have been first introduced into this country by the Department of Agriculture for this purpose twenty-five or thirty years ago. It is an excellent plant for quickly covering unsightly objects or arbors. The Florida Experiment Station published an article on the velvet bean in a bulletin issued in 1895, with the suggestion that it might be a useful forage plant. Since then it has attracted considerable attention in the Southern States, where it has come into extensive use and is highly valued, especially as a fertilizer in orange groves.

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[1] For full discussions on "Velvet Bean" see Bulletin No. 104, Alabama Experiment Station, and Circular No. 14, Division of Agrostology, U. S. Dept. of Agriculture.

The velvet bean is a trailing or climbing annual legume, with leaves resembling those of the cowpea and clusters of purple flowers at intervals of 2 or 3 feet along the stem. Later these form clusters of short, cylindrical pods, covered with a black velvety down which has given the plant the name of velvet bean. Each pod contains from 3 to 6 large, rounded, brown and white mottled seeds. It is an excellent soil renovator, having exceedingly large coral-like clusters of tubercles as large as a hen's egg. This mass contains about 6 per cent of pure nitrogen. The vines attain great lengths, sometimes growing from 30 to 50 feet in favorable localities. These may be cut for hay, which is greatly relished by all kinds of stock, or turned under as a green manure for the improvement of the soil.

Being a native of the Tropics, it matures seed only in Florida and the lower half of the States immediately along the Gulf coast. Wherever it ripens seed it is considered to be equal or superior to cowpeas, but where seed must each year be purchased it is not as valuable as that crop. In Florida the seed is sown in drills 4 feet apart, dropping from 2 to 4 seeds in hills 2 feet apart in the row. Planted in this way it will produce a mass of vines and foliage to the depth of 15 to 20 inches, covering the entire surface of the ground. From 20 to 30 bushels of shelled beans per acre is an average crop. It will completely destroy Bermuda grass, nut grass, and other troublesome weeds, and may perhaps check the Johnson grass.

During the years 1898 and 1899 thirty-four packages of the seed of velvet bean were distributed by this division. This distribution included experimenters in 8 different States. Very favorable reports have been received from Louisiana, North Carolina, Texas, and Virginia. Nineteen reports have been received, 3 recording failures, 2 unsatisfactory, 8 good, and 6 excellent.

The following reports from experimenters in different States will indicate something as to its value as a forage plant.

ALABAMA.

Mr. A. W. Orr, Deer Park, Washington County:

The ground was plowed and harrowed and the seed sown May 15, 1898, by dropping the seed into holes 2 by 6 feet apart made with a hoe. The velvet bean was in full bloom by October 10, and produced about 3 or 4 tons per acre of good forage. My stock will not eat it, but my neighbor planted some seed I gave him, and his sheep are crazy for it and eat vines and all.

Mr. T. A. Foster, Braggs, Lowndes County:

The seed was sown in sandy soil, between rows of peach trees, April 15, 1899. I opened the beds as for cotton, and dropped 3 beans in hills 3 feet apart and covered with a board. The crop was hoed once and a sweep run through twice. It was in full bloom by August 10. Only about one-third of the crop matured, on account of frost. The beans that did mature were very good. If it would mature seed and its fertilizing properties were as good as cowpeas it would be very valuable, as the yield of vines is about four times that of peas on poor land. I shall give it further trial.

FLORIDA.

Mr. B. L. Hickman, Churchill, Marion County:

A thin, sandy upland soil which was full of weeds and trash was used. The seed was sown June 1 and July 15, 1899, by dropping 2 or 3 beans 18 inches apart in every fifth or sixth furrow. Having planted velvet beans two years before, this season I did not keep the Department seed separate, but planted it with seed saved from last year's crop. As I had an abundance of other forage, I did not cut any for hay, but left the vines on the land to improve it. The yield per acre is immense. I had about 40 bushels of seed from about an acre. Horses, cattle, and hogs eat the beans when soft. I am now feeding some hogs in pens on dry beans from last year's picking, and they eat them greedily and improve rapidly. I planted some seed this year which was 2 years old and found that it germinated equally as well as that saved from last year. A great many of the beans left in the field last year were frozen in the the winter, perhaps half. The balance sprouted and in many places made a good broadcast stand.

GEORGIA.

Mr. C. M. Booth, Monroe, Walton County:

A rich dark-red soil was prepared the same as for cotton. The velvet bean yields a luxuriant crop of vines, but frost came too early and caught the young beans before they were ripe. I think farther South the bean might do well, but here on parallel 34° the season is rather short.

Mr. R. P. Johnson, Plains, Sumter County:

The seed was sown in drills about the middle of April and covered with a small double coverer. They should have been planted earlier, as the frost got them before the seeds matured. The quality of the product is excellent and I think it would make hay equal to the peavine and be equally as good a renovator. This patch was followed with oats, and they were the finest and rankest oats in the field. The velvet bean is gaining favor in Florida and southern Georgia, and is fast coming to the front in this section.

LOUISIANA.

Mr. Irving E. Baker, Bastrop, Morehouse County:

A well-fertilized garden soil was plowed and harrowed and the seed sown about April 20, 1898. About July 1 it began to grow, and covered nearly all the fences, outhouse, and several trees by September 1. I have not harvested yet as I am waiting for the pods to dry. None, however, were fully ripe when frost came on September 15. It makes a tremendous growth of vines, running 40 feet. Horses seem to like it better than anything else.

MISSISSIPPI.

Mr. A. S. Herrington, Dollie, Jones County:

A sandy, pine-ridge soil in good condition was prepared as for cowpeas. The seed was planted June 23, 1899. Our test was to compare the bean with the cowpea. We planted some of each the same day, the bean occupying the land probably twice as long as the cowpea and making a third more growth. We deem it, however, inferior to the cowpea.

NORTH CAROLINA.

Dr. William Paul Moore, Jackson, Northampton County:

As to velvet bean, I am an advocate of it. I read a short article from Mr. Wilson, of Orlando, Fla., and was so impressed that I wrote him as to price of seed. I read his answer to several gentlemen, and we ordered a barrel. The weather was such that mine did not mature, but the foliage was immense. Capt. R. B. Peebles did not plant his until this year, and he is so much pleased that he will plant 10 acres next year. His vines now are about 4 feet deep and a mass of foliage. Everything eats it, as Wilson says. Cattle will leave other feed to devour it. Mr. John Moore, of this place, who ordered when I did, but did not plant until this year, secured a large growth. I gave some of the seed to different people for arbors and shade trellising, and to my surprise many of the seeds matured, so that they have again a pretty mass of vines at their doors. I had as many as 35 pods on one stem last year.

TEXAS.

Mr. Alex. McKee Robinson, Ada, Montgomery County:

I planted the bean April 1, 1898, with corn, using about 1 peck of the beans to the acre and about the same amount of corn as is usually used in a cornfield. I planted on poor, sandy hammock land, used no fertilizer, and plowed only once in two weeks after plants had come up. I was then so busy with my tobacco crops that I neglected the beans entirely—in fact, I gave the beans up to the weeds, but as I had planted in with corn, the vines wrapped around the stalks, and outgrew the weeds and everything else and made such a mass of vegetation that it was impossible to ride through on a horse. I can give you no idea of the number of bushels per acre the vines yielded, for I did not have any of the seed gathered until after the 15th of last December, and then only some 50 or 60 bushels, on account of not being able to spare the hands to do the work.

This season, however, I am giving the beans all the attention they need and am cultivating them in just the same manner as we cultivate corn. I am informed that the vines make fine forage and fertilizer, but have had no experience with them as such, as I raise the beans for the market and had no trouble in disposing of those I had gathered at $3 per bushel. I believe that the bean will do better this year than last on account of its having had one year's growth in this section. Last spring I planted a few beans by the side of the chimney at my home and fertilized a little with cotton seed meal. The vines are now about 30 feet up the side of the chimney and are still growing very rapidly.

VIRGINIA.

Mr. C. H. Constable, Warsaw, Richmond County:

The velvet bean made a tremendous growth and had a very pretty bloom, making a handsome vine for the garden. It made a nice load of hay from the seed sent.

When cutting it I found one plant well advanced in seed and covered it with pine brush; the beans are well filled but not quite dry yet. I will let you know next year if they germinate, and if they do we may be able to raise them in Virginia.

Mr. J. M. Hughes, Claremont, Surrey County:

A good clay loam was plowed in March and well prepared. The seed was sown May 15 in rows 3½ feet apart and 8 inches in the rows. By October 27 there were many full-sized pods but none ripened. As the frost ripened the vines I cut them for feed. From the seed received I planted about 10 square rods and had about all two good horses could draw (green). As to its value for forage, I think if the seed were planted in hills with corn to hold up the vines there would be few plants that would equal it, and had I planted them earlier I think some would have ripened.

SAINFOIN, ESPARCETTE, (Onobrychis sativa).

(Plate XI, fig. 2.)

A deep-rooting, perennial legume, 1 to 2 feet high, with round, striated stems and compound leaves. The leaflets are arranged in from 8 to 10 or more pairs with an odd terminal one. It is a native of the limestone districts of central, southern, and temperate Asia, and was introduced into England from France several hundred years ago, where it has been extensively cultivated on hilly, calcareous soils too barren for the growth of clover and alfalfa. In many parts of Switzerland where the finer grasses will not grow it is the main dependence for forage. Parkinson, as early as 1640, says that it is "generally known to be a singular food for cattle, causing them to give a store of milk."

The Hon. William H. Crawford, of Georgia, is said to be the first to introduce sainfoin into the Southern States about the year 1820. Strange to say, it is but little known throughout the country at the present time. This is chiefly due to the fact that it is very difficult to establish. The plants are very tender when young and easily killed. In order to insure success, the soil must be thoroughly drained and friable and the seed sown broadcast on the surface and thoroughly rolled. The crop should not be pastured or cut the first season, but when once well rooted it will endure pasturing and cutting for a long term of years. When made into hay it should be cut as soon as the first flowers appear. The quality of the hay will then be more nutritious and palatable, the second crop of foliage more abundant, and its duration prolonged. It is a strong food and good for working horses. Cattle are also fond of it when cut green, and sheep are said to highly relish it. Our special agent at Abilene, Texas, reports that although he did not sow it until May, he secured plants 12 to 18 inches tall, which stood the dry weather better than the vetches, clovers, or alfalfas, and quite as well as sulla. He thinks that there is no better forage plant for barren hills or hillsides. Twelve packages of the seed of sainfoin have been distributed and 5 reports received.

Mr. F. A. English, Farmington, Whitman County, Wash., reports:

The seed was sown by hand May 1, 1899, on well-prepared black loam, summer followed. Only one-third of a stand was secured, but it is now (November 1) in fair condition for winter. From my former trial in 1896, I should judge that sainfoin may prove to be a valuable forage plant for this country. The plants are vigorous and it has done well on a small scale.

Mr. Jas. K. Metcalfe, Silver City, Grant County, N. Mex.:

> The seed was sown broadcast in May and in August on rich gravelly soil and covered with a heavy garden rake. It produced about half a ton to the acre, and grows about like alfalfa if well irrigated. Nothing will eat it until it is hard frozen. I think it would make a good late winter pasture, as horses, cattle, and sheep eat it to the ground in winter, but in summer time they simply walk through it and only smell of it.

METCALFE BEAN (Phaseolus retusus).

(Plate VI, fig. 2.)

A prostrate, often trailing, legume, with a very large taproot, compound leaves, and purplish flowers. It is found growing wild along the mountain streams of western Texas and New Mexico. The root is considered among the natives as one of the best blood purifiers. Mr. James K. Metcalfe, of Silver City, N. Mex., was the first to introduce this plant into cultivation a few years ago. He secured a few seeds from the mountains in New Mexico and planted them in his garden. In 1897 the Department received 5 seeds from him and later 50 more. Such excellent success crowned his efforts that he offered to let the Department have 20 pounds of seed. This was secured from him at the rate of $5 per pound. Twenty-two packages of the Metcalfe bean have been distributed to the following States and countries:

Arizona, Florida, Nebraska, New Mexico, Oregon, Pennsylvania, Texas, Utah, Washington, Cape Colony, Tunis, Madeira Islands.

Our special agent in charge of grass and forage plant investigations at Abilene, Tex., reports as follows:

> It is a prodigious grower of vines, but there were no indications of flowers or seed pods. I am afraid the season here may not prove long enough for the production of flowers or seed. Some of the vines by July 1 grew to be from 8 to 12 feet long. Then the hot and dry winds began and continued for many weeks. Up to August 1 the vines held their own fairly well, then they gave way rapidly and by September 1 even the roots were dead. I shall try the Metcalfe bean again, however, another season and am confident good results will follow with a normal season. At all events, with my present experience, I commend it highly for soiling and hay purposes.

Our special agent in the State of Washington also reports having succeeded in producing an abundance of vines by the use of irrigation, but the seed did not mature.

In the grass garden of the Department at Washington, D. C., the Metcalfe bean germinated, but made a very slow and feeble growth. Some fews pods were produced, but these, together with the leaves, turned yellow with the approach of slight frost in October and dropped off.

Mr. Metcalfe recommends the following method of harvesting the bean:

Take a sharp hoe, clip them at each hill and let them dry for one or two days. Then rake with horse rake and put into small cocks. When dry, haul and stack. If wanted for hay, cut when about half the pods have turned yellow.

The following letters from Mr. Metcalfe and the testimonials from other experimenters will indicate its value as a forage plant:

JANUARY 23, 1898.

I send you in this letter 50 Metcalfe beans. I am satisfied it is our coming forage plant. Few plants here are more relished by stock; even deer climb the cliffs for it. Be sure and plant the bean in rich deep-tilled land, about as you would for watermelons.

Yours, truly,
JAMES K. METCALFE.

NOVEMBER 10, 1898.

I have only 30 pounds of beans (*Phaseolus retusus*). I had bad luck with them. We had 8 inches of hail in June, which cut off every leaf and tender ends of the vines. The vines had to make a new growth. Those from beans planted on the 15th of May were a sight to look at. They were simply shingled with bean pods, but the frost killed them all and left the green pods lying on the ground side by side, like myriads of small fishes. If they had only ripened, I believe I would have had over a ton of beans. The 30 pounds which I secured were nearly all from 60 2-year-old vines. If the hail had not hit them, I believe they would have produced nearly 100 pounds of seed. Next year, without hail or frost, I will have several tons. It is a sure producer and an excellent feed. Five or six hundred plants to the acre the second year will mat the ground with vines and beans. Cattle and sheep will quit any kind of feed for it. They even lick up the leaves. Hogs eat it ravenously. It must be a rich food. Some of my vines measured 13½ feet long. When we consider that so few beans will cover an acre of ground, and make such a yield of fodder and beans, we must believe that it is something wonderful.

Yours, truly,
JAMES K. METCALFE.

Mr. J. S. Argobrite, Los Angeles, Los Angeles County, Cal.:

A rich, sandy loam was plowed and harrowed and irrigated 4 times, using as much water as would grow a good crop of melons. The seed was sown May 2 in rows 4 feet apart and 2 feet in the row. The crop was cultivated once when the plants were 1 foot high. It was not harvested, but pastured to stock, as it was impossible to use a machine, owing to its prostrate growth. It was in full bloom July 25, but it did not ripen seed. The estimated yield of vines was about 4 tons per acre. The average growth was about 5 feet long. It is not a true climber, but runs over the ground like a melon, and is of no more value than the ordinary pole bean. Another small plot was sown on sandy soil and not irrigated. To date (November 1) it has made a growth of 1 foot and is still green and growing with many blossoms, but no seed.

W. Atlee Burpee & Co., Doylestown, Bucks County, Pa.:

A heavy clay loam was plowed and harrowed. The seed was sown May 3 and planted to poles set 4 by 4 feet apart. A horse cultivator was used. By September 8 the plants had a running growth, with rather thick, smooth, light-green leaves. It is only now starting to run freely and showing flower buds, but no pods have set.

Mr. B. Fritz, Blue Springs, Gage County, Nebr.:

The seed was sown on a well-prepared loamy soil May 15, 1899, in rows 8 feet apart with hills 4 to 6 feet apart in the rows, 1 seed in each hill. It was cultivated with a small garden rake and a hoe. The date of full bloom was from the 10th to the 15th of September, but it did not ripen on account of frost about September 25. The vines were set full of pods and spread over the ground from 6 to 8 feet in every direction. Cattle and horses will eat them and seem to relish them.

Prof. A. J. McClatchie, Experiment Station, Phœnix, Ariz.:

A gravelly loam was used which had been thoroughly ploughed and harrowed. The seed was sown April 12, 1899, in hills 3 by 3 feet, and cultivated until the runners prevented. It blooms in August. As the Metcalfe bean is a perennial, it is too early to give results and estimates of value. The tops died down during September.

Mr. J. A. Mickelson, Elcampo, Wharton County, Tex.:

The seed was sown March 25, 1899, on well-prepared partly black sandy soil. Furrows were made with a garden hoe and the seed covered about 1 inch deep. It seems as if every seed germinated. I cultivated once by running a sweep between the beds, which were 4 feet apart. The bean grew well and had long vines, but unfortunately the Brazos flood of June and July affected us here in this community, though only by heavy rains, which scalded the majority of crops here and killed the Metcalfe bean. I am under the impression, however, that the bean would prove valuable here.

CRIMSON CLOVER (Trifolium incarnatum).[1]

An erect, tufted, rapid-growing, annual legume from 1 to 2 feet high, with soft hairy leaves and usually bright scarlet flowers in elongated heads. It is a native of the Mediterranean region, and although it has been long cultivated in the warmer portions of Europe it has only recently come into prominence in this country. In the Middle and South Atlantic States this clover is one of the best crops that can be grown for forage and soil renovation. The general results of investigations carried on in the North and Northwest show that it is too tender for that climate and is less valuable than red clover. It is an excellent crop for use as hay, soiling, pasturage, silage, green manure, and as a cover crop. The hay when well cured is superior to red clover, has a somewhat higher percentage of digestibility, and is relished by all kinds of stock. On dairy farms it is especially valuable for soiling purposes, as it is ready for use some time before red clover, and at a time when there are few other crops at hand. In the early spring it makes excellent pasturage either alone or in conjunction with winter rye or rape. The quality of ensilage which it produces is better than that from most other leguminous plants and is highly valued for feeding to dairy stock. When used as a green manure, it exerts a most beneficial effect on the condition of the soil, adding much humus and nitrogen, as well as other valuable elements of plant food. As a cover crop it can hardly be surpassed. When sown after the last cultivation, it will serve to prevent the soil from leaching out or washing badly, to conserve the moisture during the long periods of dry weather, to reduce the amount of labor necessary to keep weeds in check, and to supply the soil with an abundance of nitrogen.

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[1] For full discussion of Crimson Clover see Circular No. 17, Division of Agrostology. and Circular No. 18, Division of Botany, Department of Agriculture, Washington, D. C.

Forty-three packages of crimson clover seed have been distributed for trial, but most of it in the spring of 1899, so that the number of reports are few.

Twelve experimenters have reported, and out of these there were 7 failures, 3 unsatisfactory, and only 2 good reports.

Mr. P. S. Early, Mockville, Davie County, N. C.:

> The seed was sown October 1, 1897, on rich red clay soil, which had been thoroughly prepared by deep plowing and harrowing. It was cut about April 25, 1898, and yielded splendidly at about 2 tons to the acre. The quality of the forage is good, and for an early green crop the very thing for this section.

Mr. George Williams, Potomac, Prince Williams County, Va.:

> I planted the crimson clover September 20, 1899, with a garden hoe, and made the ground in fine condition. It is now (December, 1899) looking well and promising.

ALSIKE CLOVER (Trifolium hybridum).

A common, perennial legume, 1 to 3 feet high, with branching leafy stems bearing white or rose-colored flower-heads. It is especially adapted for cultivation in wet meadows or marshy lands, and will not withstand severe drought. The leaves are slightly bitter, and on this account the forage is not so well liked by stock as that of red or white clover. As it can endure very low degrees of temperature, it can be cultivated in the far North and in high altitudes very successfully. Twenty-three trial packages of the seed of alsike clover have been distributed from this division since 1896, but only five experimenters have reported the results obtained, and of these only three were favorable.

Mr. W. H. Heideman, Kalispell, Flathead County, Mont., says:

> A rather moist, rich, sandy loam was used, which was plowed and harrowed twice. The seed was sown without a nurse crop May 4, 1898, then smoothed with a lever harrow and rolled. As the season was cold and rainy, it did not mature seeds, but the quality of the fodder was good. None of it was killed out during the severe winter weather, and it is now pretty well demonstrated that clover can be made a paying crop here when grown for forage, but questionable as to the production of seed. It grew very heavy, but not very tall. The yield would be at least one and one-half tons to the acre.

RUSSIAN RED CLOVER (Trifolium pratense var. pallida).

A large quantity of the seed of this variety was obtained for the Department through Prof. N. E. Hansen in 1898 from the experiment station at Valnjka, province of Samara, Russia. During the years 1898 and 1899, 344 3-pound packages were distributed by this Division through the Section of Seed and Plant Introduction. This distribution includes experimenters in 37 different States, and 152 experimenters have reported the results of their trials. Very favorable reports have been received from Illinois, Indiana, Kansas, Michigan, Minnesota, Montana, Nebraska, New York, Oregon, and Wyoming, but longer experimentation is necessary before we shall be able to say whether it is of any more value to the country than the common red clover. The following are a few of the reports from experimenters who have already found that it is hardier and more drought resistant than the common red clover:

ILLINOIS.

Mr. A. B. Cundiff, Blairsville, Williams County:

A clay loam was plowed the latter part of March, 1898, and seeded to oats. The clover seed was sown on the oat ground about April 20, 1898, and harrowed one way. The clover came up nicely and made a rapid growth and at the present time is making a good pasture. I regard it as a valuable addition to our varieties of clover, both for pasture and hay.

INDIANA.

Mr. Henry Wehry, North Vernon, Jennings County:

A clay loam in medium condition was plowed in the fall of 1897 and left in the rough furrow. The ground was harrowed twice in the spring with a tooth harrow and the seed sown March 9, 1898, then harrowed again with a spike harrow. This variety grew about the same as ordinary red clover, being about 8 inches high. With the exception that it may be a little hardier and more drought-resisting I can see no difference between it and the common red clover grown in this country.

KANSAS.

Mr. John B. Harman, Valley Falls, Jefferson County:

A clay loam on a northeast slope was pulverized 3 to 4 inches deep, then plowed, harrowed, and rolled. The seed was sown June 4, 1898, with a cyclone seeder, then harrowed in, rolled, and brushed lightly. It came up in about four days, but barely lived through the dry months of July and August. It looks green now (October 24), and is as high as the stubble. I think it is better than our common clover, but the weather was so cold and wet that the ground did not get into condition to sow the seed in time to give the clover a fair show.

MONTANA.

Messrs. William W. Gamble & Sons, Choteau, Teton County:

A gravelly loam on bench land was plowed and harrowed well. The seed was sown broadcast with a hand seeder May 19, 1898. The clover wintered all right and was in full bloom by July and ripe in August. The quality of the product is good. It grows well and yields heavily with us. I think it is of considerable value.

Mr. A. H. Geyer, Victor, Ravalli County:

A sandy loam with a clay subsoil was used. It was well drained, mellow, and in fine condition. The seed was sown about the middle of April. The crop was irrigated through June and July. It had fully matured by the beginning of August. The yield per acre was from 1 to 2 tons, according to the condition of the soil. The product is of fair quality, about 2 feet high and somewhat course. The leaves are small and pointed and similar to alfalfa. It is a fair forage plant.

Mr. W. H. Heideman, Kalispell, Flathead County:

A medium, rich, sandy loam was plowed and harrowed twice before seeding. The seed was sown broadcast May 4 without a nurse crop and covered by rolling

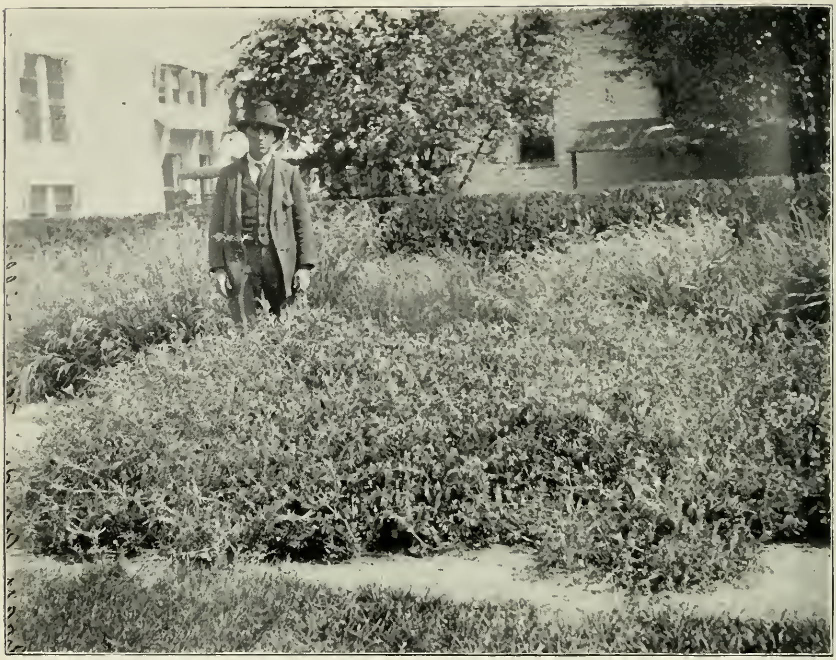
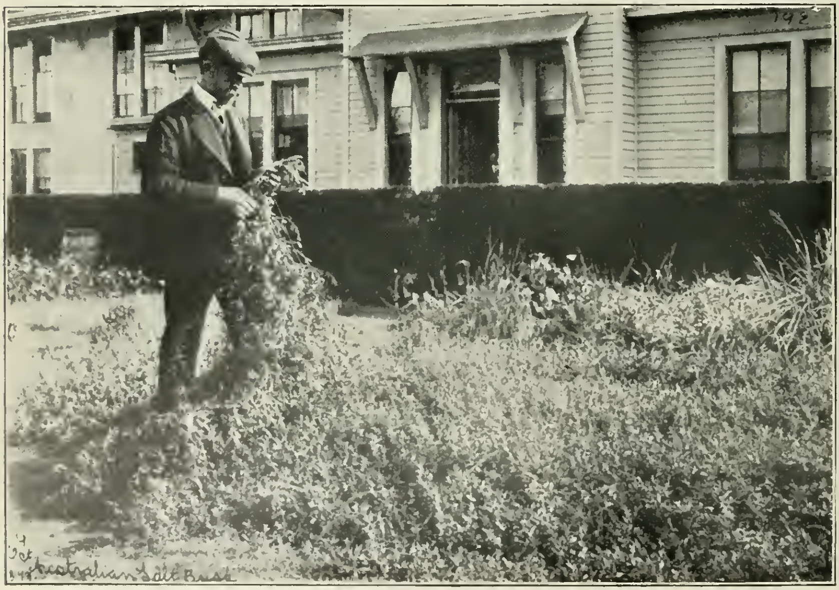


FIG. 1.—HAIRY VETCH, GRASS GARDEN, WASHINGTON, D. C.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Australian Salt Bush

FIG. 2.—AUSTRALIAN SALTBUSH IN GRASS GARDEN, WASHINGTON, D. C.

the ground. This clover stood the severe winter of 1898–99 and came out in fine condition, making a fine crop. The estimated yield was about 2½ tons to the acre. The quality of the product was good. I am still more convinced that we will succeed in growing clovers in this section. This clover makes a very strong growth and seems to stand the drought well and is perfectly hardy. It is looking green and healthy at this time (November 18, 1899), but I can not yet say whether it will produce seed here.

Mr. C. H. Williams, Deer Lodge, Deer Lodge County:

A sandy loam with a clay subsoil was plowed and harrowed. The seed was sown broadcast May 15, 1898, and covered lightly with a harrow. The crop was irrigated, and came into full bloom about August 15, 1899. The yield per acre would be about 1½ tons of first-class hay. It grows rapidly and will be of great value as winter feed for sheep or cattle.

Mr. C. C. Willis, Plains, Missoula County:

A sandy soil with a clay subsoil on bench land was used. Bunch-grass land that had been grown to weeds four or five years was plowed up and prepared for the clover. The seed was sown broadcast with oats May 24, 1898, and thoroughly harrowed in and rolled. It came up in a short time. We had a very good season, with plenty of showers in June, and the clover was in bloom by July 15. The yield per acre was from 2 to 2½ tons. The quality of the product was good and stock ate it well. It is a vigorous grower and I think it will be a good forage plant, as dry weather seems to affect it very little.

SOUTH DAKOTA.

Hon. H. C. Warner, Forestburg, Sanborn County:

A black, sandy loam was plowed deep and harrowed. The seed was sown broadcast April 24, 1898, and covered with a brush harrow. The stand was perfect, but a cold dry fall and cold open winter killed 50 per cent of it. The remaining plants, however, made a good growth this season until July, when they were attacked by grasshoppers which ate the foliage and blossoms as fast as they appeared. It is 5 per cent hardier than the common red clover growing by its side.

HAIRY VETCH (Vicia villosa.)[1]

(Plate XII, fig. 1.)

A leafy, annual, trailing, leguminous plant, which has been cultivated in Europe for over fifty years, especially in Southern Russia, Germany, and France. It was first introduced into this country in 1847, but its cultivation was neglected. About twelve years ago it was reintroduced by this Department, and since then it has been widely distributed and successfully tried in various parts of the United States. The results of experiments with it on the trial grounds of the Department at Washington, D. C., prove that it is quite hardy and continues to grow all winter during periods of open weather. At the Mississippi Agricultural Experiment Station the hairy vetch has given heavy annual crops on the same ground since 1888 without receiving any special care, the plants self-sowing the plat each season. It will grow readily on poor sandy soils, but is most profitable as a forage plant on rich and well-prepared land. Poor lands can be supplied with the necessary plant food for the growth of other crops by growing hairy vetch for several years. It forms a mulch on the land all summer by its matted growth, kills the weeds, and mellows the soil as much as any hoed crop, without the labor required for the latter.

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[1] For full discussion of Hairy Vetch, see Circular No. 6, Division of Agrostology, Dept. of Agriculture, Washington, D. C., and Bull. No. 105, Alabama Experiment Station.

Hairy vetch may be sown any time in the spring in the North, Northwest, and East, but for the South and Southwest it has been found more successful to sow in the fall, some time in September or October. It should be sown broadcast or with a grain drill at the rate of 1 to 1½ bushels to the acre. The seed is yet quite expensive, which, to some extent, prevents it from occupying a prominent place in American agriculture. However, a number of our correspondents are reporting the successful raising of seed, and it seems quite probable that this country will soon be producing sufficient seed for its own use.

Hairy vetch is eaten with relish by all kinds of stock. It is valuable for soiling, ensilage, green manure, cover crop, and for hay, although for the last-named purpose it is difficult to cure on account of its dense habit of growth.

Excellent reports have been received in regard to its drought-resisting qualities and its adaptability to our climate from Colorado, Georgia, Idaho, Indiana, Iowa, Kentucky, Massachusetts, Michigan, Minnesota, Nebraska, Montana, New Mexico, North Carolina, Pennsylvania, South Carolina, South Dakota, Wisconsin, District of Columbia, and Mississippi. The seed was distributed to experimenters in 40 different States, and reports have been received from 27 States. Thirty-four packages of the seed of hairy vetch were distributed during the fiscal year 1896–1897; 332 packages during 1897–98, and 98 packages during 1898–99, making a total of 464 packages since 1896.

The request to the experimenters for a report as to their success or failure was complied with by 206 farmers out of the 444 receiving seed. Out of these, 86 resulted in failures, 43 were unsatisfactory, and 76 reported having had good results, while 6 speak of it in the very highest terms.

The following reports from the various States will indicate its great value throughout the country. In many instances only the salient points are extracted from the reports, leaving out the kind of soil and method of sowing and cultivation adopted:

ARKANSAS.

Mr. J. B. Nixon, Charleston, Franklin County:

When sown by itself it is of a spreading nature, and to secure the best results should be sown with wheat, or in the spring with oats, barley, or spring wheat. I think it will be an acquisition to the forage plants here. It did not have a fair trial last season, owing to the excessive drought.

CALIFORNIA.

Mr. Andrew Boddy, Monrovia, Los Angeles County:

The vetch is good as a forage to cut green and feed to stock, and if irrigated can be cut several times in a season. I had some experience with this plant in Canada in 1868 and 1869, and it gave good satisfaction at that time.

Messrs. Guill Brothers, Chico, Butte County:

The growth was very rank, some of the vines being 7½ feet long and full of pods. I should think it would be fine for sheep and hog pasture. I shall try it along that line another season.

Mr. P. H. Murphy, Perkins, Sacramento County:

Although all the other varieties failed to grow, this vetch made a good growth during the summer months on all the different soils. I found it excellent for green feed for hogs and cattle. If planted in January in our climate, it will make a good crop. I consider it a good green soiling crop. It does best when sown with barley or oats.

Mr. K. J. Provost, Grafton, Yolo County:

A rather heavy clay land near a river bank was used. The soil was plowed once and put into good condition. The seed was sown March 2, 1898, and then the land was harrowed and cross harrowed. The vetch made a vigorous growth. After the first cutting it grew again over 2 feet tall and formed a dense matted growth. From the growth made and the relish with which cattle eat it, I believe it to be a valuable adjunct to our crops.

GEORGIA.

Mr. E. J. Hartman, Orr, Gilmer County:

The hairy vetch made a feeble growth at the beginning, but came out well later on, and is now showing satisfactorily.

Mr. T. A. Stafford, The Rock, Upson County:

The yield per acre and quality of the product were very good. I think it might be worth quite as much as any good hay. The chickens and pigeons got most of the seed.

IDAHO.

Mr. Ellis M. Cameron, Postfalls, Kootenai County:

A gravelly loam was used, which had been plowed, harrowed, leveled, and rolled. The seed was sown with a press drill about the middle of April, the first of May, and the middle of May. It was then brushed and rolled as the plants showed above ground. The yield per acre was about 2 tons, and the quality of the product excellent. I believe it will make an excellent plant for soiling, for a green manure, and probably would make good ensilage. It is a very valuable plant for the dairymen of this country, and as a catch crop for late pasture.

ILLINOIS.

Mr. A. R. Downy, Rapids City, Rock Island County:

The seed started well, but was severely tested by the cold winter of 1898–99, which, by the way, was the coldest known for years. The following season the growth was fine, and I believe the vetch will prove valuable.

INDIANA.

Miss Kate A. Drake, Elkhart, Elkhart County:

It must be a valuable plant for our section, as it defies drought and cold, and cattle, horses, hogs, and hens are very fond of it.

Mr. Henry Wehry, North Vernon, Jennings County:

A clay loam of medium quality was used; it had been plowed 8 inches deep, heavily manured, and pulverized with a spike-tooth harrow. The seed was sown with a wheat drill at the rate of 44 quarts per acre May 21. The vines were cut October 15, when they were still in full bloom. No pods had formed, and the blossoms all wilted and fell off. I think it would have yielded about 2 tons of dry hay per acre. Some of the vines were 10 feet long, and it was the hardest stuff I ever undertook to cut. The forage is of good quality and liked by all kinds of stock. It would make a fine crop to turn under. The greatest drawback is the expense of the seed.

IOWA.

Mr. E. L. Hayden, Oakville, Louisa County:

The seed did not germinate well, and the plants grew slowly until the 10th of July. After that date they grew very fast until the time of cutting. The second growth is now (October 17) about 6 feet and in full bloom, with some of the pods ripe at the same time. I have been pasturing it with calves. If the seed was not too costly, it would probably pay to sow it with spring grain for fall pasture or alone for green manuring.

KANSAS.

Mr. J. R. Norton, Morantown, Allen County:

The yield was heavy, but I did not gather it. Rabbits and sheep gnawed it all winter. It came up itself this spring and made a lusty growth. I think it is a valuable plant to have around. Perhaps it would make good hay.

Mr. George James, Concordia, Cloud County:

It made a good growth, but the dry weather came when it was in full bloom. I wanted the seed, so I let it go to ripen, but it did not last long when the hot winds struck it. I did not get any seed.

MINNESOTA.

Mr. S. M. Warman, Sandstone, Pine County:

The seed was sown broadcast May 19, 1898, on well-prepared new land. It grew well, and is perfectly green still (October 15), with many ripened pods with seed in them, equal in size to the seed sent. Without doubt it will be a very valuable crop to stock raisers and dairymen. I shall not be without it in future. The vines grew 15 feet long.

MONTANA.

Mr. E. Beach, Augusta, Lewis and Clarke County:

A dry, gravelly bench land was used that had been in cultivation for several years. The soil was plowed and harrowed, and the seed sown broadcast June 5 and harrowed in. It was in full bloom August 20, and was cut for hay. It is an excellent and very nutritious feed. The yield of hay is about 1 ton per acre. It also has excellent pasture growth, but as it is an annual plant, it is not desirable for that purpose in this country. On account of its growing on the ground like a vine it is not easy to harvest.

Mr. C. C. Willis, Plains, Missoula County:

The hairy vetch grows well here, and I believe it will thrive on our bench lands. Stock keeps it grazed close to the ground.

Mr. Emory Vine, Miles City, Custer County:

The hairy vetch grew well and kept blooming and ripening seed at the same time until cold weather. The yield per acre would probably be about 3 tons. Some say nothing will eat it, but I know better. It is a good drought resister, and will be better liked when better known. It is difficult to harvest, as it interlaces so, but it makes a good pasture, particularly for hogs.

NEBRASKA.

Mr. E. P. Savage, Sargent, Custer County:

The growth of the vine was heavy, but little seed was secured, as much of the seed had fell out of the pod while the plant was still in bloom. Cattle and horses eat the straw readily. I believe it to be a good plant for soiling and for hay.

Mr. Alfred Shirley, Weeping Water, Cass County:

This is an extraordinary forage plant. Hogs and all other kinds of stock eat it readily and prefer it to anything else, both when green and cured. I do not like to use it for hay, as it is so difficult to cure.

NEW MEXICO.

Mr. J. G. Kello, Aztec, San Juan County:

The yield per acre would probably be about 1½ tons. It is a first-class forage; cows and all other stock eat it eagerly. The experiment was made for the purpose of getting a crop of hay, and at the same time a stubble to turn under that would add nitrogen to our sandy soils, which are rich in phosphoric acid and potash, but poor in nitrogen. This forage plant so far has made a better showing than alfalfa, Canada peas, cowpeas, or red clover, as it germinates better than any of the above and makes more hay in less time. It also withstands drought better. For a short rotation I believe it will prove better than any of the above for our soil and climate. I am of the opinion that hairy vetch will have to be planted in the fall in order to mature seed here.

NORTH DAKOTA.

Mr. D. N. Dalrymple, Kelso, Traill County:

The vetch made a very rank, rapid growth, and if sown with oats would make an excellent soiling crop. The greater part of it was still green when the ground was frozen.

Mr. W. R. Gluyas, Hofflund, Williams County:

It looks as if it would make 4 tons to the acre. It makes an excellent growth, some of the vines being 6 feet 5 inches long. Horses did not seem to care for it, but it will no doubt prove of considerable value for such stock as will eat it.

Hon. J. A. Power, Power, Richland County:

The hairy vetch was mown July 15. After this it grew again and made a thick growth and matured seed, which was not gathreed. It stayed green until late in the fall, and was greedily eaten by horses and cattle. I believe it may have value if it will stand the climate and reseed itself.

OREGON.

Messrs. J. P. & J. O. Stemmler, Dora, Coos County:

It makes an enormous growth, branching out into runners 10 to 12 feet long. There was a heavy frost here last night, and I thought the vetch was killed, but am pleased to say it is not, but is in full bloom. One drawback is that, I fear, it will not ripen seed in this climate. It is splendid as a cover crop among trees. The yield per acre was about 3 tons.

PENNSYLVANIA.

Mr. Joseph H. Brinton, Chester County:

I experimented with *Vicia villosa* and found it admirable for subduing weeds. In forty years' experience of farming I think it the most remarkable forage plant. It seems proof against the extremes of heat and cold. All kinds of stock like it. The roots go down deep into the ground, and are covered with tubercles about the size of a grain of shot.

SOUTH CAROLINA.

Dr. J. E. Rickenbaker, Orangeburg, Orangeburg County:

On rich soil this plant makes a very rapid growth. It is well adapted for this section, but the seed is difficult to gather and the large quantity required for seeding will likely prevent its ever becoming very popular.

SOUTH DAKOTA.

Hon. H. C. Warner, Forestburg, Sanborn County:

The seeds of hairy vetch germinated well. The average length of the plants was 9½ feet. It was cut green and fed to horses, hogs, and cows, and was relished by all. I am well pleased with it, and am sure it will prove valuable for forage.

TEXAS.

Mr. Arnott West, Brownwood, Brown County:

I gave this plant no care, as there was such a small amount of seed. It produced about 2 to 2½ tons per acre. I let my milch cows graze on it, and they kept it eaten to the ground from July on. It did well for the chance it had. It will make splendid hay for this country.

VIRGINIA.

Mr. George Williams, Potomac, Prince William County:

The seed was planted in drills, between corn. I judge by the looks of the plat that every seed grew, and after the corn was taken off cows were turned into the pasture, and they seemed to be fond of it. In spite of the cattle eating it off each day, one can see the green foliage 30 rods away.

WASHINGTON.

Mr. F. A. English, Farmington, Whitman County:

I should consider the hairy vetch a good plant for dry soils of poor quality, but no comparison to brome grass as a success. Under the adverse circumstances it was remarkably good. There was barely an inch of rainfall from June 1 to September 15. I believe the plant would do better on moister ground and with occasional showers during spring and summer. I can recommend it for its staying qualities.

Mr. J. M. Scott, Kiona, Yakima County:

After the first two or three weeks the hairy vetch grew rapidly. It was frequently irrigated and soon spread over the ground, making a tangled mass of vines. It probably would yield from 2 to 3 tons per acre. The vines seem to be a rich feed. From what I have seen of this plant I should think it will withstand a great deal of drought and live, but to make a paying crop it needs a reasonable amount of water. While the plants were young all kinds of stock seemed to be very fond of them, but when the vines matured they did not seem to relish them. Mr. W. D. Taville, of Kiona, who has a wheat farm upon the high plateau known as Horse Heaven, just south of the Yakima Valley, sowed some hairy vetch this year, which, he says, did fairly well without irrigation, but there is more rain there than in the valley and the soil is better.

WISCONSIN.

Mr. J. F. Jensen, Waupaca, Waupaca County:

I have been very successful with the hairy vetch. The seed was sown in May in 1898, and made a good growth of hay. It lived through the severe winter, and this year grew to a height of 4 feet. I cut about 10 square rods and thrashed out about 1 bushel of good seed. I think this is a fine crop to grow for the improvement of our soil.

STOLLEY'S VETCH (Vicia leavenworthii).

A native annual legume, with small leaves and trailing stems similar to the common vetch. It is found growing wild in the granite regions of central and western Texas. Its value as a forage plant was first noticed by Mr. George Stolley, of Burnet, Tex., a few years ago. It is said to withstand drought remarkably well, and cattle and horses are fond of it. As it is an early forage plant, appearing in the spring before even the needle grass starts, it will be especially valuable for supplying green food at a time when it is badly needed. In the counties of Parker, Callahan, and Burnet, Tex., it has given most satisfactory results, and promises to be one of the best winter and early spring forage plants for those districts. It is also valuable as a soil mulch and green manure. About 10 packages of seed, grown by Mr. Stolley, were distributed by this division in 1898–99. Several reports have been received giving only fair results. It has not been sufficiently tested to enable us to state its usefulness.

SALTBUSHES (Atriplex).[1]

(Plate XII, fig. 2.)

The saltbushes are especially adapted for alkali lands where grasses and clovers will not grow, but they will also do well on nonalkaline soils. There are many species in cultivation, both native and introduced. A variety which is attracting a great deal of attention at the present time is the Australian saltbush. It is a rapid-growing, much-branched perennial which forms a dense mat over the ground to the thickness of from 1 to 2 feet. The leaves are small, about an inch long, and coarsely toothed along the margins. In a few weeks one plant will spread from 4 to 5 feet. The hard, somewhat pulpy fruits are produced in abundance throughout the season. They differ from many of the other saltbushes in not having the seed surrounded by a large, light fibrous covering, but have merely a very thin coating of pulp, which is tinged with red at maturity and dries out as soon as they fall from the plant. On the poorest and most stubborn arid soil, so impregnated with alkali that no other useful plant will grow, this saltbush has been known to flourish. It seems to have a remarkable number of virtues, including great frost resistance, palatability, heavy yield, sand-binding qualities, and the habit of spreading freely. Sheep are especially fond of this saltbush, and hogs eat it freely. A mixture of three parts of this forage with one part of common hay is readily eaten by horses and cattle. It is probable that under favorable conditions about 20 tons of green feed or 5 tons of cured forage could be produced from 1 acre. The introduction of this plant to owners of waste alkali lands has certainly been a great achievement. As it has almost the same nutritive ratio as alfalfa, it would seem that it must have nearly as high a feeding value. Von Mueller states that, in his opinion, many of the valuable qualities of the Australian wools are due to the abundance of this and other saltbushes in the regions in which the sheep are grazed. Owing to its thin, flexible stems it can be handled like alfalfa, while most of the other saltbushes are only fit for browsing. Of all the different species in cultivation in this country, this Australian saltbush seems to be the most promising, both because of its hardiness and the bulk of tender fodder produced.

In the grass garden at the Department of Agriculture, Washington, D. C., the Australian saltbush has produced a vigorous and widely spreading growth throughout the season. It is now fruiting abundantly, and extends 5 feet beyond the original plot which it has occupied for five years without reseeding or other care.

There are about 40 species of saltbush in the Western States, some of which will no doubt prove as valuable as those introduced from

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[1] For full discussion on "Native and introduced saltbushes," see Farmers' Bul. No. 108, U. S. Department of Agriculture. (Agros. No. 55.)

Australia. They are known to be hardy as regards cold as well as resistant to alkali and drought, and are highly valued for grazing in alkali districts where little or no other vegetation exists.

Of the American saltbushes now in cultivation, shad scale is considered to have the most economic value. It is a robust, shrubby perennial, from 4 to 10 feet high, native to the high valleys and plains of Wyoming, Nevada, Arizona, New Mexico, and western Texas. The small, narrow, gray-green leaves and young branches are browsed by cattle, which sometimes eat it down close to the ground, leaving only the stump to branch out again into new growth. The seeds are produced in great abundance, often one-half bushel or more on a plant. These are much sought after by sheep, and are considered very fattening.

In the Southwest there are large sections of country where shad scale constitutes the chief forage plant. It is so much liked by stock that on the summer ranges it occurs only on rocky cliffs or other inaccessible points. On ranges which are not grazed through the summer, where the plant has an opportunity to seed freely, it grows in great abundance and affords excellent winter pasturage. It has proved its adaptability to soils impregnated with white alkali, and also withstands small amounts of the black alkali. Its resistance to cold adds greatly to its value. Since 1896 this division has sent out 248 packages of *Atriplex* saltbushes to different experimenters throughout the United States. Twenty-nine different States are represented in this distribution, which was as follows:

Shad scale (*Atriplex canescens*), 85 packages; gray saltbush (*A. halimoides*), 37; annual or bladder saltbush (*A. holocarpa*), 29; Australian saltbush (*A. semibaccata*), 20; Nelson's saltbush (*A. pabularis*), 19; slender-fruited saltbush (*A. leptocarpa*), 18; silvery saltbush (*A. argentea*), 16; round-leafed saltbush (*A. nummularia*), 10; bladder saltbush (*A. vesicaria*), 8; Nuttall's saltbush (*A. nuttallii*), 5; Utah saltbush (*A. truncata*), 3; sponge saltbush (*A. spongiosa*), 3, and spiny saltbush (*A. confertifolia*), 3. Of the 150 applicants for seed, 52 have sent in reports, and with the exception of 12, all report that the seed failed to germinate, or that only a few plants came up and soon died.

This failure to germinate the seeds is very probably due to the methods adopted in planting. If the seeds are harrowed in to the depth of 2 or 3 inches, or sown in drills in alkali soils, they usually rot before germination can take place. The primary rule to remember is that these saltbushes are plants of the desert. Their seeds start easily and rapidly, with little or no covering, but the soil must be warm and moist. At the California Experiment Station, as well as on the trial grounds of the Department at Washington, D. C., it has been determined that the seeds germinate better when sown directly on the surface without any covering. Some practical stockmen have had good results in establishing saltbush on alkali ranges by sowing the seed on the ground when it was wet with heavy rains, and at once driving a flock of sheep over the land, thus treading the seed into the soil. In order to obtain a satisfactory stand, however, the heat must be adequate.

Almost without exception farmers who have attempted to cover saltbush seed on alkali soils have found that it rotted in the ground before germination could take place. For California the best time to sow is about the latter part of September or the beginning of October, when one is able to catch the first autumn showers. Plants may be grown by sowing the seed in boxes or garden beds, covering very lightly, and planting out the seedlings when a few inches high, several feet apart, on alkali spots. Many have followed this method with success, and thus have utilized every seed obtained. In districts where the seed is being experimented with for the first time, and in case of small lots, this method is to be recommended.

As the saltbushes are remarkable for their ability to adapt themselves to varied conditions, this method would enable the plants to become acclimated, and the seed would be more likely to germinate well. The California Experiment Station sums up the points in brief, as follows: Sow early, on the surface; press seed into the soil, but do not cover; protect from birds, which are very fond of the seeds.

Although no extensive experiments have been made with sowing saltbush seed on nonalkaline soils, yet it seems to be an advantage to cover them slightly.

WINTER FAT; SWEET SAGE (Eurotia lanata).

(Plate XIII, fig. 1.)

A half-shrubby perennial, 1 to 3 feet high, with numerous small gray leaves and slender woolly twigs. It is found growing wild throughout the Rocky Mountain region from British Columbia to Mexico. An important fact in regard to this plant is that it will thrive on both alkali and nonalkali soils. In western Texas and in the more arid regions of Arizona, Nevada, and Utah it is very highly valued for winter forage. The cottony seeds are produced in great abundance, and both seeds and stems are eaten greedily by all grazing animals; so that this plant is now almost exterminated wherever cattle have free range. It has been growing in the grass garden of the Department of Agriculture at Washington, D. C., for several years, and grows almost as well in dry as in wet weather, producing a fine growth of forage. Stock grazed on lands where winter fat occurs make a rapid growth, and are said to be remarkably free from disease, because of the tonic properties of the plant. Seed might be gathered by ranchmen and sown in the spring on land which had been disked or

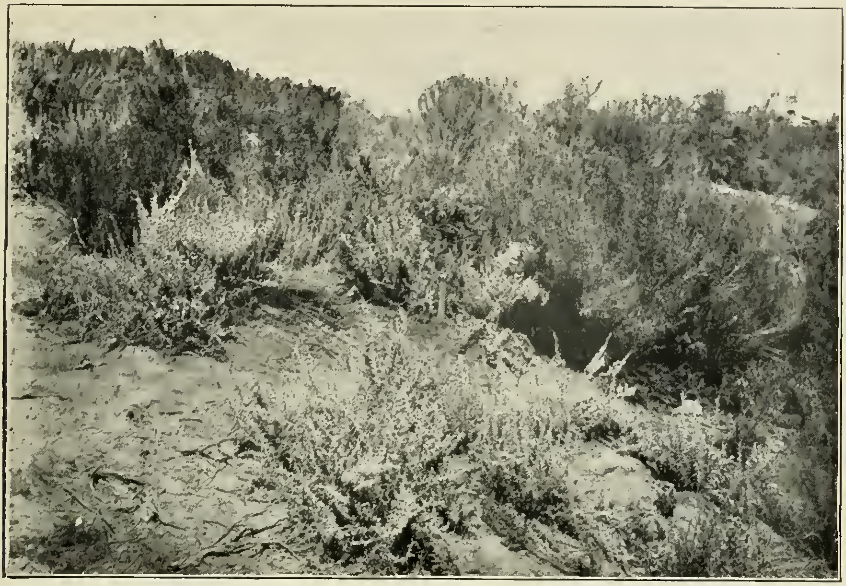

FIG. 1.—WINTER FAT; SWEET SAGE (EUROTIA LANATA), NATIVE GROWTH.

From a photograph by A. B. Leckenby.

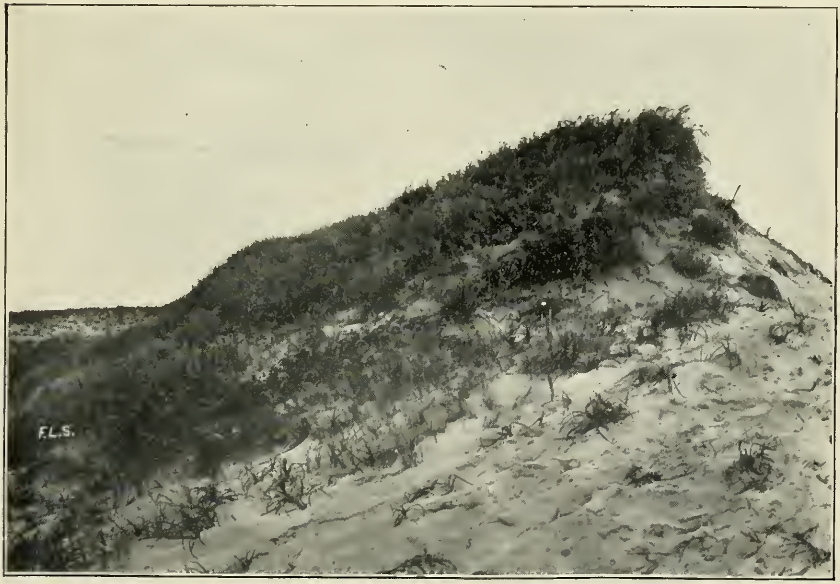

FIG. 2.—SAND DUNE FORMED BY SEASIDE BLUE GRASS (POA MACRANTHA) NEAR SEASIDE, OREG.

From a photograph by F. Lamson-Scribner, 1899.

harrowed, and while it could not be cut for hay, owing to its shrubby nature, yet it would make excellent winter browsing for either sheep or cattle. Since 1896 thirty-eight packages of the seed of winter fat have been distributed by this division. Eleven reports have been received, but most of the experimenters seem to have had difficulty in growing it successfully under cultivation. Our special agent at Walla Walla, Wash., however, finds that it adapts itself readily to cultivation, producing an abundance of seed.

TSAMA WATERMELON (Citrullus vulgaris).

(Fig. 1.)

A few seeds of this variety were received from Professor MacOwan, government botanist for Cape Colony, and distributed to the Arizona and California experiment stations, with the hope that a quantity of seed might be produced for general distribution. The Tsama watermelon is a native of the Kalahari Desert, in South, Africa, where it is often the only supply of water for travelers crossing these arid regions. It is especially adapted to withstand great extremes of temperature and drought, and hence might be valuable for wide introduction through the deserts of Arizona and southern California.

Professor MacOwan writes:

> The waterless regions would be impassable but for its perfectly tasteless watery contents. It is merely a variety of *Citrullus vulgaris* with tasteless and nonpurgative pulp. The vines grow rapidly and spread many feet, yielding a large quantity of round melons 4 inches or more in diameter.

Tsama watermelon has grown and matured in the grass garden of the Department of Agriculture at Washington. The California Experiment Station is now distributing the seed of this melon under the erroneous name of Khama watermelon, with the following notice:

> This curious little stock melon came from the Kalahari Desert, in South Africa, and is said to grow well on exceedingly arid soil. At Pomona substation, without water, on sandy soil, it yielded at the rate of 22 tons to the acre. Cows and horses eat the melons readily.

At the experiment stations of Arizona and California it grew luxuriantly, as the following report will show.

Mr. J. W. Mills, foreman, Sub-experiment Station, Los Angeles, Cal.:

> A reddish-brown, sandy loam was plowed 10 inches deep in October, 1898, irrigated in January, 1899, replowed in February, and cultivated until June. The seeds were planted in hills 12 by 24 feet between rows of fruit trees on June 5, 1899. The plants came up well and were thinned, leaving two in a hill. The crop was cultivated only once before the vines covered the ground. It was in bloom from July to October 1. In quality it is about on a par with the melon known as pie melon, stock melon, or citron. The vines grew about 12 to 15 feet long, producing from 120 to 160 melons per hill. The crop was harvested about November 1, 1899, when about one-fourth of the melons were ripe. The yield per acre if planted 15 by 15 feet would

be about 40,000 pounds. Cows and horses eat the melons readily. Hogs do not care for them. The melons when on the vine have a peculiar and bad odor, which passes away after they have been harvested a few days. The odor seems to come from the hairs that grow on the rind.

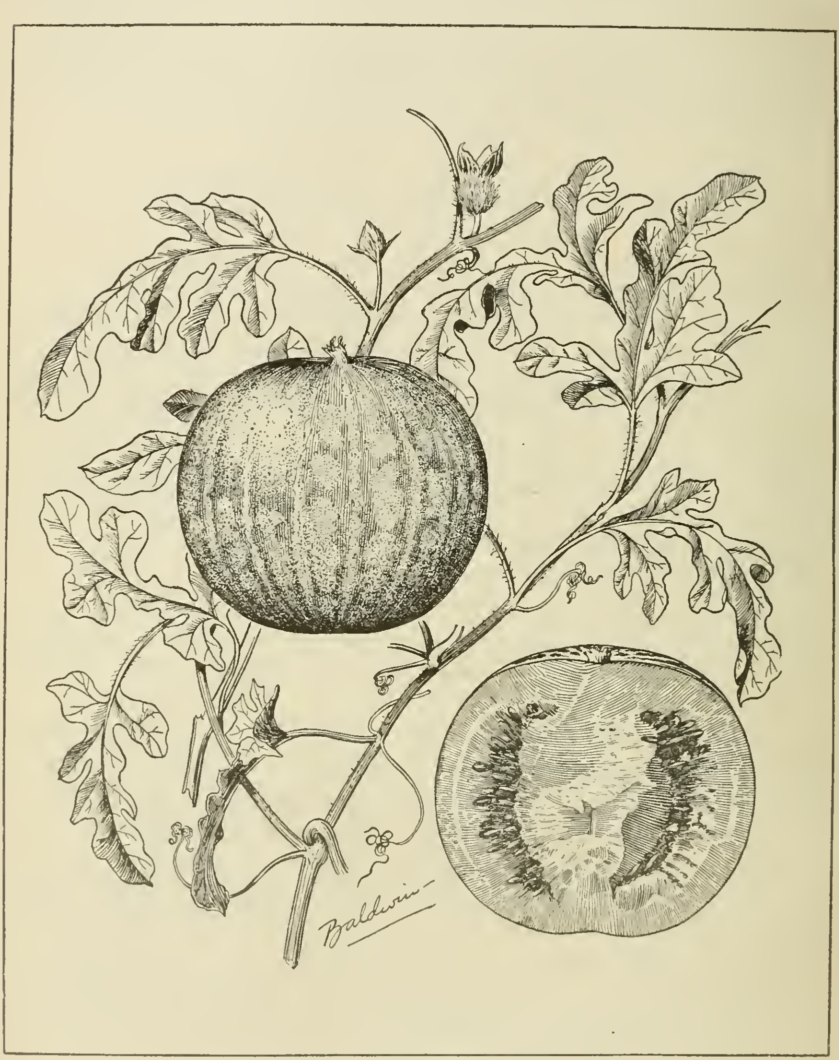

Fig. 1.—Tsama melon (*Citrullus vulgaris*).

Prof. A. J. McClatchie, Experiment Station, Phenix, Ariz.:

A well-prepared, sandy loam was used. The seeds were planted in rows 6 by 8 feet on April 10, and well cultivated during the early part of the season. The crop was in bloom by May, and ripe melons were produced during July, August, and September. It grows luxuriantly and is evidently good feed for stock. It seems to be suited to our climate and stands the drought well.

BULLETIN No. 23. Agros. 65.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY.
[Grass and Forage Plant Investigations.]

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STUDIES
ON
AMERICAN GRASSES.

A REVISION OF THE NORTH AMERICAN SPECIES OF BROMUS OCCURRING NORTH OF MEXICO.

BY

CORNELIUS L. SHEAR,
Assistant Agrostologist.

PREPARED UNDER THE DIRECTION OF F. LAMSON-SCRIBNER, AGROSTOLOGIST.

ISSUED JULY 3, 1900.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Agrostology,
Washington, D. C., April 9, 1900.

Sir: I have the honor to transmit herewith the manuscript of a paper entitled A Revision of the North American Species of Bromus Occurring North of Mexico, prepared under my direction by Mr. Cornelius L. Shear, assistant agrostologist, and recommend the same for publication as Bulletin No. 23 of this division, under the general title of "Studies on American Grasses."

The abundance of good material collected during the past few years in the Rocky Mountains and the Northwest has shown the necessity of a revision of the genus *Bromus*. Until very recently good specimens from these regions have been few, and their identification has rested in many cases on tradition and misconceptions of the species. As an illustration of this, the case of *B. breviaristatus* may be cited. The identification of this species was based by Thurber and Gray on specimens distributed by Hooker under that name. These specimens when compared with the original illustration of the species and the actual type prove to be the old and well-known *B. unioloides*. The examination of portions of the types of Hooker, Link, and Nuttall has made it possible to treat more satisfactorily the various forms from the same region that have passed for *B. ciliatus* and its varieties. Thus *B. vulgaris*, which is one of the best-defined species of the Northwest, has heretofore passed as *B. ciliatus* or *B. purgans*, or a variety of one or the other. The group presenting the most difficulties in the way of satisfactory segregation is that to which *B. carinatus* and *B. marginatus* belong. Here the forms and variations are so many and perplexing that the present disposition of them is necessarily more or less tentative. In the thorough study of the group Fournier's Mexican forms must be considered, and these are so confused and poorly segregated that only a comparison of his types can make a satisfactory disposition of them possible.

The present paper contains descriptions of 36 species and 28 varieties, 45 of which are natives and 19 introduced. The enumeration includes a new subgenus, 3 new species, and 15 new varieties.

Respectfully,

F. Lamson-Scribner,
Agrostologist.

Hon. James Wilson,
Secretary of Agriculture.

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A REVISION OF THE NORTH AMERICAN SPECIES OF BROMUS OCCURRING NORTH OF MEXICO.

INTRODUCTION.

It does not appear that any attempt has heretofore been made to revise the species of *Bromus* of any very extensive region. In the present paper the species of North America north of Mexico are treated. Those of Mexico are so poorly known that no satisfactory disposition can be made of them until more extensive collections have been examined and the types of Fournier's species and varieties studied. A careful study of the types of the species of Humboldt, Bonpland and Kunth and Presl from the region of the Andes is also necessary in order to correctly understand our southwestern and Mexican species of the subgenus *Ceratochloa*.

The number of known species of *Bromus*, according to Bentham in his "Notes on Gramineæ" in 1881, was about 40. This is the most recent estimate, but according to Index Kewensis and the study of recent literature a total of 150 species would be a conservative estimate of the number at present known. The number of species and varieties described in this paper is 64. Of these 45 are indigenous, and the remaining 19 adventive or introduced. Three are regarded as new species, and fifteen as new varieties. A few species credited to North America still remain doubtful or unknown to us. These have been added at the end of the paper with their original descriptions.

We desire here to acknowledge our great indebtedness and express our thanks to the following botanists who have rendered valuable assistance in the preparation of this paper, either by the loan or contribution of material or by the copying of original descriptions or plates: Drs. B. L. Robinson, Wm. Trelease, N. L. Britton, J. K. Small, P. A. Rydberg, and I. Urban, also Sir W. T. Thiselton-Dyer, Miss Alice Eastwood, and Prof. C. V. Piper.

CLASSIFICATION.

The first step necessary in revising a genus is to decide what shall be considered its type. Then follows the question of its limitations. In this case, as in so many others, Linnæus, who is cited as the author of the name, was not the first to apply it to a genus. In Gen. Pl. ed. 4, 26. 1752, he cites Monti (Cat. Stirp. Agri. Bonon. Prod. 32. 1719) as the author of the genus. For figures of species which he evidently regarded as typical he cites Scheuchzer's Agrost. Helv. Prod. *pl. 5. figs. 2, 10, 11, 12.* 1708. Referring to Scheuchzer's figures, No. 2 appears to be a species of *Deschampsia*, which Linnæus one year later, Sp. Pl. **1**: 65. 1753, refers to *Aira cæspitosa*, but does not mention it under *Bromus*, so it is rather evident that the reference to it under that genus was an error. The next figure cited, 10, is undoubtedly a *Bromus*, and is referred by Linnæus to B. *arvensis* l. c. by citation of description but not of figure. By some error on the part of Scheuchzer, his figure 10 is referred to on different pages as representing two different things. Figure 11 Linnæus refers in the same place to *B. squarrosus* and figure 12 in the first edition of "Species Plantarum" is referred to *B. tectorum*, but in the second edition it is referred to *B. mollis* (*hordeaceus*), which it evidently is. Thus it is sufficiently clear what section at least of the genus as here treated, Linnæus had in mind as the basis of his genus. But according to the present rules of American nomenclature, 1753 is taken as the starting point for genera as well as species. Following this, some arbitrary means must be resorted to in deciding what shall be recognized as the types of Linnæus's genera, since there are no generic descriptions in the "Species Plantarum." The most simple and logical plan we believe would be to adopt the first species mentioned as the type, which, applied to the case in hand, would make the type of our genus *B. secalinus*, thus bringing about in this case practically the same results as by the first method, as the species first referred to by Linnæus, *B. arvensis*, *B. squarrosus*, and *B. mollis* are all intimately related to *B. secalinus*.

This genus in the sense in which it is here treated has been the subject of many divisions and subdivisions; at least ten different genera based upon various species have been proposed. The present tendency among many botanists is toward the narrower limitation of genera, but it has seemed best in this paper to maintain the genus in its broadest sense. Of the various genera proposed *Ceratochloa* is perhaps, on the whole, the best defined, while the subgenus *Neobromus* is rather anomalous, and may be eventually found worthy of generic rank. This subgenus, which includes so far as at present known only *Bromus trinii* and its several varieties, shows very close relationship with *Avena* and *Trisetum*, to each of which genera forms of it have been referred. In its various forms it appears to have reached its greatest development in the Andes of South America and is restricted in its distribution to the western portion of the western continent.

The following list shows in order of their publication the various genera proposed for species here included in the genus Bromus:

Lasiopoa Ehrh. Beitr. **4**: 147. 1789.

Ceratochloa Beauv. Agrost. 75. *t. 15. f. 7.* 1812.

Schedonorus Beauv. Agrost. 99. 1812. This, apparently by mistake, stands *Schenodorus* in the index, 177, of the work cited. Beauvois included under *Schedonorus* mostly species of *Festuca.* He cites no type for the genus, so we have accepted the first species mentioned, *Festuca elatior* L., as the type. Only one or two species of true *Bromus* were included by him, one of which was *B. inermis.*

Zerna Panz. Denkschr. Acad. Münch. 296. 1813.

Michelaria Dum. Obs. Gram. Belg. 77. *t. 16.* 1823.

Libertia Lej. Nov. Act. Nat. Cur. **12**: 755. *t. 65.* 1825.

Serrafalcus Parl. Pl. Nov. 75. 1842.

Anisantha C. Koch, Linnæa **21**: 394. 1848.

Triniusia Steud. Syn. Pl. Gram. 328. 1854.

Bromopsis Fourr. Ann. Soc. Linn. Lyon n. ser. **17**: 187. 1869.

Zerna was originally made to include the species of the subgenus *Stenobromus* as well as those related to *B. asper.*

Michelaria and *Libertia* are synonyms, both being founded on *B. arduennensis* Dum., a Belgian species resembling *B. squarrosus* somewhat but having the angle on the margin of the flowering glume extended in the form of a tooth.

Serrafalcus was applied to the group containing *B. secalinus* and closely allied species, which Linnæus regarded as typical of his genus *Bromus.*

Anisantha was founded on *B. pontica* Koch, which is considered to be *B. tectorum* L.

Bromopsis was applied to *B. asper* and *B. erectus*, and is synonymous with *Zerna*, as here emended.

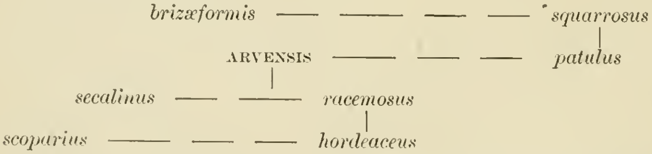
Triniusia was founded on *B. danthoniæ* Trin., and may be a valid genus. It is not represented in our territory.

The greatest difficulties in the treatment of the subject are connected with the segregation and delimitation of species and varieties. In order to arrive at a stable basis for the foundation and separation of species, it is quite necessary that one should know exactly what the type of each species is. Various authors differ as to the limitation of species, and it can scarcely be expected that there will be a unanimous opinion as to these limitations, but if the typical form of a species be recognized and taken as the fixed point that must remain undisturbed, however many or few forms may be grouped around it, much confusion would be avoided. As a basis of the present revision we have made a careful study of the original descriptions of the species and also have had an opportunity of examining the types or portions of the types of the most of our endemic forms. This has shown the necessity of a number of changes in the nomenclature of our species, the determination of some of them having heretofore rested upon traditions and interpretations, which investigations of the types prove to be incorrect. Besides the study of original descriptions and types, we have had an opportunity to study most of the forms in the field during the past five seasons, and have also been able to examine the collections of a number of the larger herbaria of this country. The species, as in most of our genera of wide distribution, are very variable, and their separation becomes to a great extent a matter of personal judgment, and hence arbitrary. Nearly all of the so-called specific characters are variable. The most common variations are in the amount and distribution of the pubescence, the width of the glumes and leaves, and the length of the awns. In most instances the amount and distribution of the pubescence of the flowering glume, taken in connection with other corelated characters of the plant, have been found to furnish a fair basis for segregation, especially where these characters are found to coincide with geographic distribution and environment. It has been found, however, that a character which seems fairly stable in one species may be much more variable in another, so that no character in general can be said to have specific value, but the value of each character must be determined by careful study and observation of the plants throughout a considerable territory. Species founded on single characters are always artificial, rather than natural. There are scarcely any of our species that do not show intermediate forms. In some instances, of course, these are much more numerous than in others. The subgenus *Ceratochloa* presents the most numerous and perplexing forms. These seem to be largely due to the wide distribution and varied climatic and physiographic conditions under which they are found.

The advisability of the adoption of so many varieties may perhaps be questioned by some as tending to make nomenclature too cumbersome. As the chief value of the work, however, seems to us to lie in bringing out as clearly as possible the degrees of relationship and relative importance of the various groups as well as their connection with physical environment and geographical distribution, this course has been followed as best serving the end in view.

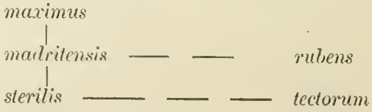
An attempt is here made to illustrate diagrammatically what appears to us the relationships of the subgenera and species.

The first group, *Bromus* proper, is made up entirely of forms which have been introduced from Europe.

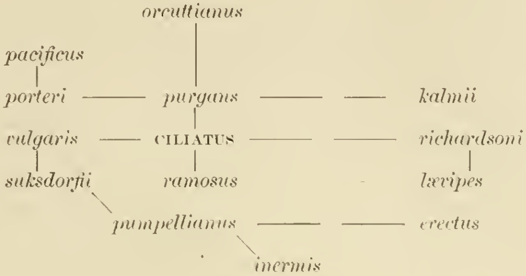


The second group, subgenus *Neobromus*, represented by one species and its varieties, shows no close relation with our other species, but seems to approach nearest *B. scoparius* and *B. tectorum*.

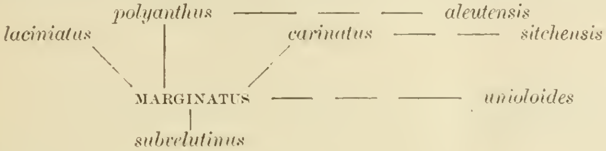
The subgenus *Stenobromus* also consists entirely of introduced species.



The subgenus *Zerna* as here emended contains the largest number of our endemic species. They are widely distributed throughout our region and are quite variable.


orcuttianus
pacificus
porteri
purgans
kalmii
vulgaris
CILIATUS
richardsoni
suksdorfii
ramosus
lævipes
pumpelliamus
erectus
inermis

The subgenus *Ceratochloa* is apparently peculiar to the western portions of North and South America, ranging from Alaska to Cape Horn.


polyanthus
aleutensis
laciniatus
carinatus
sitchensis
MARGINATUS
unioloides
subvelutinus

It is impossible to represent by diagram, except in a very general way, the various relationships of a species. If the species diverged along one or two lines, it would not be so difficult; on the contrary, each shows more or less variation in several directions, so that the typical form might more properly be regarded as a center from which lines diverge in various directions.

The results of this study, which seem to us of most general scientific importance, are those which give us a clew to the derivations and relations of the various species. It will be noticed that comparatively few synonyms are given under the species. By listing all the synonyms given by various authors a very long but unreliable list might have been made; it has seemed to us preferable, however, to restrict the synonymy to those names whose identity we have been able to verify, either by the examination of the types or of authentic material. In rare instances we have been obliged to accept the authority of those who have had excellent opportunity for comparison and study of the species referred to.

DISTRIBUTION.

The genus *Bromus* is most widely distributed in the temperate and mountain regions of the world. The genus seems to have reached with us its greatest development in the Rocky Mountains. In the tropics the species are almost entirely restricted to the higher mountains. Some of the species are more or less distributed in arctic regions also. The highest altitude reached by any species is about 4,000 meters, in the Rocky Mountains of Colorado. The species is *Bromus* *porteri.* In the Rocky Mountain region and on the west coast we have abundant representatives of the *Ceratochloa* group, which is found from western Alaska to Cape Horn, but is not represented, so far as we know, on the Eastern Hemisphere, except by introduced forms of *B. unioloides.* Our species in the Northwest show an intimate connection with some of those in eastern Siberia. This is especially marked in the case of *Bromus pumpellianus*, whose Siberian equivalent is *B. inermis.* Unfortunately we have not sufficient material of Siberian species at hand to carry farther the comparison. In the South many forms of the subgenus *Ceratochloa* are connected by way of the mountains through Mexico and Central America with those of the Andes, so that it will be necessary, in order to make a comprehensive and satisfactory disposition of this group, to study carefully representatives from the Andes region, as well as from farther south.

ECONOMIC IMPORTANCE.

A number of species are of economic importance, either on account of their value as forage or because of their weedy propensities. Ranking first as a forage plant comes *Bromus inermis* (smooth or Hungarian brome grass). This species, introduced from Europe, has been extensively tried in the semiarid portions of the West and found to be well adapted to the conditions prevailing there. It is excellent for either hay or pasture.

Bromus unioloides, usually sold under the name of Schrader's brome grass, is another species which has been cultivated considerably in the southern parts of the United States.

Bromus secalinus, cheat or chess, though usually regarded as a weed in grain fields in the East, is cultivated for hay quite extensively in western Oregon and Washington.

Bromus pumpellianus, a native of the northern Rocky Mountain region, has been tried in cultivation and found very promising. It is very closely related to *Bromus inermis* and adapted to similar conditions of soil and climate.

Bromus marginatus latior has also been used for hay to some extent in Oregon and appears worthy of further attention.

Nearly all of the introduced species show decided weedy propensities and are quite troublesome, especially on the west coast. *Bromus hordeaceus* and its variety *glabrescens* have taken possession of vast areas (see *B. hordeaceus*) of deteriorated range land in California, Oregon, and Washington. *Bromus sterilis*, *B. maximus*, and *B. madritensis* are also common weeds in grain fields and waste places in the same States.

BROMUS L. Gen. Pl. 15. 1737.

Spikelets few to many-flowered, slightly or more rarely strongly flattened laterally, in panicles, or rarely racemed; rachilla articulated above the empty glumes and between the florets; florets hermaphrodite or the uppermost imperfect; empty glumes at the base of the spikelet 2, unequal, acute, or the second short-awned, 1 to 7 nerved, shorter than the flowering glumes; flowering glumes keeled or more often rounded on the back, 5 to 9 nerved, usually 2-toothed at the apex, awned from the back just below or from between the teeth, sometimes awnless; awn straight or divergent, sometimes twisted. Palea usually a little shorter than the glume, 2-keeled. Stamens usually 3. Stigmas plumose, sessile, springing from below the hairy cushion-like apex of the ovary. Grain furrowed and grown to the palea. Annual or perennial grasses with flat leaves and rather large, erect or pendulous spikelets.

The genus is very closely related to *Festuca*, from which it differs in general in its larger spikelets, more or less dentate apex to the flowering glume and in the character of the ovary, and the habit of growth which is very rarely cæspitose. Some species show close relationship with *Avena*, *Trisetum*, and *Danthonia*, while others are very close to *Melica*.

ANALYTICAL KEY TO THE SPECIES AND VARIETIES.

1. Flowering glume with pubescence about equally distributed over the whole dorsal surface 2
1. Flowering glume with pubescence conspicuously unevenly distributed over the dorsal surface, longest and densest on the margins or base or both 25
1. Flowering glume smooth or scabrous 36
2. Spikelets 5–9 mm. broad, laterally flattened before flowering 3
2. Spikelets usually less than 5 mm. broad before flowering and terete or subterete . 6
3. Awn not exceeding 7 mm. long, usually shorter 4
3. Awn usually more than 7 mm. long 24
4. Leaves linear, somewhat involute and pilose-pubescent .. **30 B. subvelutinus.**
4. Leaves linear-lanceolate, flat 5
5. Panicle narrow, lower branches not exceeding 10 cm. long. **31 B. marginatus.**
5. Panicle rather broad, some of the lower branches exceeding 10 cm. long .... **31 B. marginatus latior.**
6. Panicle rather lax and drooping in flower 7
6. Panicle as a whole not conspicuously secund or drooping in flower 17
7. Perennials, native 8
7. Annual, introduced .... **14 B. tectorum.**
8. Species restricted to the Rocky Mountains and westward 9
8. Species east of the Rocky Mountains 14
9. Lower empty glume 1-nerved, lanceolate, acute 10
9. Lower empty glume 3-nerved, broadly lanceolate, subacute .... **19 B. porteri.**
10. Lower empty glume 5 mm. or more long 11
10. Lower empty glume usually less than 5 mm. long ... **19β B. porteri havardii.**
11. Sheaths densely pilose-pubescent .... **19α B. porteri lanatipes.**
11. Sheaths not densely pilose-pubescent 12
12. Empty glumes more or less pubescent 13
12. Empty glumes smooth .... **19γ B. porteri frondosus.**
13. Culm tall, stout; panicle heavy .... **20 B. pacificus.**
13. Culm rather slender; panicle not heavy .... **23 B. vulgaris.**
14. Lower empty glume 1-nerved, acute 15
14. Lower empty glume more or less distinctly 3-nerved .... **18 B. kalmii.**

15. Sheaths without a ring of pilose pubescence at the base of the blade........ 16

15. Sheaths with a ring of pilose pubescence at the base of the blade........ **20α B. purgans latiglumis.**

16. Sheaths densely soft pilose-pubescent .... **21γ B. purgans incanus.**

16. Sheaths sparsely pilose-pubescent or nearly smooth .... **21 B. purgans.**

17. Flowering glumes acute or subacute with not more than 5 distinct nerves ... 18

17. Flowering glumes broad, obtuse or sub-obtuse, 7-nerved........ 22

18. Awn of flowering glume straight at maturity 19

18. Awn more or less twisted and divaricate at maturity........ 21

19. Branches of the panicle rather rigid and spreading in fruit . **22 B. orcuttianus.**

19. Branches of the panicle not rigid nor broadly spreading........ 20

20. Leaves of the innovations narrow and involute........ **26 B. erectus.**

20. Leaves not involute and panicle not strictly erect .. **21β B. purgans texensis.**

21. Panicle more than 2 dm. long........ **9α B. trinii pallidiflorus.**

21. Panicle smaller; mostly less than 2 dm. long........ **9 B. trinii.**

22. Awn twisted and divaricate at maturity 23

22. Awn not conspicuously twisted or divaricate........ **3 B. hordeaceus.**

23. Panicle dense; usually less than 12 cm. long.. **3α B. hordeaceus intermedius.**

23. Panicle looser; more than 15 cm. long .... **9 β B. trinii excelsus.**

24. Leaves of the innovations numerous, narrow ..... **35δ B. carinatus linearis.**

24. Leaves of the innovations few; more than 2 mm. broad ..... **35 B. carinatus.**

25. Panicle rather broad, loose and drooping........ 26

25. Panicle rather narrow and erect or not conspicuously drooping 31

26. Awn more than 6 mm. long 27

26. Awn less than 6 mm. long........ 29

27. An introduced species with broad, loose panicle........ **15 B. ramosus.**

27. Native species, with rather narrow panicles........ 28

28. Leaves and sheaths glabrous; leaves usually more than 7 mm. broad .... **23α B. vulgaris eximius.**

28. Leaves and sheaths more or less pilose-pubescent; leaves less than 7 mm. broad .... **23β B. vulgaris robustus.**

29. Flowering glume pubescent above the middle on the margin and across the lower half of the back... 30

29. Flowering glume ciliate-pubescent on the margin, the pubescence extending very little above the middle........ 31

30. Ligule 2 mm. or more long; plants with creeping rootstocks ... **24 B. lævipes.**

30. Ligule less than 2 mm. long; plants without creeping rootstocks .... **17 B. richardsoni.**

31. Native of the Rocky Mountains westward and northward........ **17α B. richardsoni pallidus.**

31. Native of the Northeastern States and northward........ **16 B. ciliatus.**

32. Panicle broad, branches widely spreading in flower, introduced.. **27 B. inermis.**

32. Panicle rather narrow with erect or ascending branches 33

33. Panicle narrow and rather rigidly erect; flowering glume short-pubescent or puberulent on the margin .... **25 B. suksdorfii.**

33. Panicle not rigidly erect........ 34

34. Awn wanting or not exceeding 2 mm.; flowering glume with margin short-pubescent .... **28β B. pumpellianus melicoides.**

34. Awn usually exceeding 2 mm........ 35

35. Margin of the flowering glume very densely ciliate-pubescent nearly to the apex .... **28α B. pumpellianus tweedyi.**

35. Margin of the flowering glume with shorter pubescence not reaching to the apex .... **28 B. pumpellianus.**

36. Spikelets large, somewhat laterally compressed before flowering 37

36. Spikelets not flattened laterally before flowering 49
37. Awn exceeding 7 mm. long 38
37. Awn less than 7 mm. long 41
38. Flowering glume very broadly lanceolate, subacute, distinctly 7-nerved .... **33 B. aleutensis.**
38. Flowering glume lanceolate, acute, usually 5-nerved 39
39. Flowering glume 18–20 mm. long; awn 11–15 mm. long .... **35β B. carinatus hookerianus.**
39. Flowering glume 14–16 mm. long; awn 7–10 mm. long 40
40. Panicle very broad, longest branches 15 mm. or more long, lax and drooping; leaves broad .... **34 B. sitchensis.**
40. Panicle narrower, longest branches less than 15 mm. long; leaves rather narrow .... **35α B. carinatus californicus.**
41. Panicle erect or suberect, lower branches rarely more than 10 cm. long 42
41. Panicle with upper part more or less drooping; lower branches rather weak, the longest usually more than 10 cm. long 46
42. Awn wanting or less than 4 mm. long 43
42. Awn 4 mm. or more long 44
43. Spikelets about 1 cm. broad, Briza-like .... **7 B. brizæformis.**
43. Spikelets narrower, not resembling those of Briza .... **29α B. unioloides hænkeanus.**
44. Flowering glumes scabrous-puberulent 45
44. Flowering glume smooth or merely scabrous .... **32 B. polyanthus.**
45. A native of the southwest, Arizona, and southward .... **35ε B. carinatus arizonicus.**
45. A native of the northwest, Wyoming, Oregon, and northward .... **31β B. marginatus seminudus.**
46. Palea more than three-fourths the length of its glume 47
46. Palea three-fourths the length of its glume or less .... **29 B. unioloides.**
47. Panicle rather lax and open, not dense 48
47. Panicle large, suberect, and rather dense .... **35γ B. carinatus densus.**
48. Plants with broad leaves, usually more than 7 dm. high .... **32α B. polyanthus paniculatus.**
48. Plants usually less than 7 dm. high with rather short, narrow leaves .... **36 B. laciniatus.**
49. Awn distinctly twisted and divaricate 50
49. Awn not distinctly twisted and divaricate 52
50. Panicle short and dense .... **8 B. scoparius.**
50. Panicle rather large and open 51
51. Spikelets usually more than 5 mm. broad in flower .... **6 B. squarrosus.**
51. Spikelets 5 mm. or less broad in flower .... **5 B. patulus.**
52. Panicle short and contracted 53
52. Panicle rather broad and open 56
53. Flowering glumes elliptic .... **3β B. hordeaceus glabrescens.**
53. Flowering glumes narrow-lanceolate 54
54. Awn 35 to 40 mm. or more long .... **11 B. maximus.**
54. Awn less than 30 mm. long 55
55. Panicle forming a dense head rarely exceeding 5 cm. long .... **12 B. rubens.**
55. Panicle less dense and usually longer .... **10 B. madritensis.**
56. Flowering glumes elliptic or ovoid-lanceolate 57
56. Flowering glumes oblong lanceolate to narrow-lanceolate 60
57. Margins of flowering glumes not strongly involute in fruit 58
57. Margins of flowering glumes strongly involute in fruit .... **1 B. secalinus.**
58. Panicle rather small and subracemose .... **2 B. racemosus.**
58. Panicle rather large and broad 59

59. Spikelets less than 6 mm. broad in flower .... **4 B. arvensis.**
59. Spikelets more than 6 mm. broad in flower ... **2α B. racemosus commutatus.**
60. Awn more than 15 mm. long 61
60. Awn much less than 15 mm. long, sometimes wanting 62
61. Awn usually more than 35 mm. long .... **11α B. maximus gussoni.**
61. Awn usually less than 30 mm. long .... **13 B. sterilis.**
62. Awn usually less than 3 mm. long .... **27 B. inermis.**
62. Awn usually more than 3 mm. long .... **16α B. ciliatus læviglumis.**

I. BROMUS PROPER.

A. *Annuals or sometimes biennials with empty glumes rather broad and the flowering glume broadly elliptic to oblong-elliptic. Species all introduced.*

1. BROMUS SECALINUS L. Sp. Pl. **1**: 76. 1753. *Serrafalcus secalinus* Bab. Man. Brit. Bot. 374. 1843. (Fig. 1.)

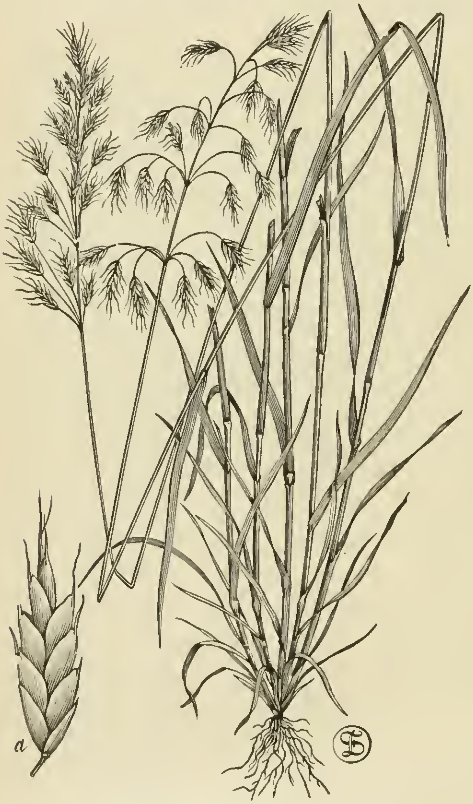


Fig. 1.—*Bromus secalinus: a*, spikelet.

An erect annual. Culm 3–7 dm. high, smooth throughout or somewhat pubescent at the nodes. *Sheaths typically smooth*, sometimes the lowest sparsely pilose-pubescent; ligule about 1 mm. long, truncate, somewhat irregularly dentate; blades mostly 1–2 dm. long, linear-lanceolate, with coarse, sparse hairs above, smooth beneath. Panicle about 8–18 cm. long, at first erect, the upper part drooping in fruit, pyramidal in outline; *lower branches 3–5*, unequal. *Spikelets ovoid-lanceolate, becoming somewhat laterally compressed and turgid in fruit*, 10–18 mm. long,[1] 6–8 mm. broad in fruit; empty glumes smooth, obtuse, the lower 4–6 mm. long, 3–5-nerved, the upper broader, *6–7 mm. long*, 7-nerved; flowering glumes 7-nerved, 6–8 mm. long, elliptic, obtuse, smooth or scabrous, *having the margin strongly involute in fruit*, shortly bidentate at the apex *with the undulate awn mostly 3–5 mm. long*, inserted about 1 mm. below the apex; *palea equal to or only very slightly shorter than its glume.*

General distribution: This species, introduced from Europe, is very generally distributed throughout the United States.

Specimens examined.—*Maine:* N. Berwick (J. C. Parlin 566). *Ontario:* Galt (W. Herriott). *Connecticut:* Fairfield (E. H. Eames). *New York:* Oxford (F. V.

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[1] All measurements of spikelets and glumes are exclusive of the awns.

Coville). *Pennsylvania:* Philadelphia (I. C. Martindale 15). *Delaware:* Centreville (A. Commons 135, 136). *Maryland:* Rocky Springs (J. E. Miller). *District of Columbia:* Washington (G. Vasey); (T. H. Kearney, jr.). *Florida:* Chipley (R. Combs 684). *Alabama:* Tuskegee (G. W. Carver). *Tennessee:* Hiwassee Gorge (T. H. Kearney, jr. 311). *Ohio:* Pittsfield (A. E. Ricksecker); Youngstown (R. H. Ingraham). *Indiana:* Millers (L. M. Umbach). *Michigan:* Thunder Bay Island (C. F. Wheeler). *Wisconsin:* Near Webster (L. S. Cheney 3430). *Minnesota:* Wilmar (W. D. Frost); Cannon Falls (J. H. Sandberg 327). *Iowa:* Minerva (C. R. Ball 9); Ames (C. R. Ball 35, 150); Newmarket (B. Shimek 12). *Missouri:* St. Louis (Drummond 647). *Texas:* Ennis (J. G. Smith); El Paso (E. A. Mearns 1479, 1482). *New Mexico:* Cliff (J. K. Metcalfe). *Arizona:* Near Flagstaff (D. T. McDougal 303). *Utah:* Provost (M. E. Jones 5499); Ogden (T. A. Williams 2482); Salt Lake City (M. E. Jones 1009). *Colorado:* Estes Park (J. Ball); near Silverton (C. L. Shear 1239). *Wyoming:* Near Beulah (David Griffiths 405). *Montana:* Bozeman (P. A. Rydberg 2214; C. L. Shear 453); Garrison (C. L. Shear 368). *Idaho:* Farmington Landing (Sandberg, Heller & McDougal 531); Forest (H. E. Brown 26). *Washington:* (Leiberg & Sandberg 399); Waitsburg (R. M. Horner 564); Walla Walla (C. L. Shear 1557, 1597). *Oregon:* McMinnville (C. L. Shear 1618); Corvallis (M. Craig 9344). *California:* Dixie Valley (J. B. Davy).

This plant is very closely related to several other species, especially *B. racemosus* and *B. arvensis.* It differs from both in the character of the spikelet at maturity, the florets being much spreading and the margin of the flowering glume being strongly involute.

2. **BROMUS RACEMOSUS** L. Sp. Pl. ed. 2. **1**: 114. 1762. *Serrafalcus racemosus* Parl. Rar. Pl. Sic. **2**: 14. 1840. (Fig. 2.)

An annual or biennial, with erect or ascending culm 3–7 dm. high, *usually scabrous-puberulent just below the panicle* and pubescent at the nodes. *Sheaths rather densely pilose-pubescent, at least the lower ones;* ligule about 1 mm. long, lacerate-dentate; blades linear, rather narrow, mostly 7–14 cm. long, pilose-pubescent below or on both surfaces. *Panicle typically simple* sometimes with 2–3 branches below, mostly somewhat nodding. Spikelets 15–20 mm. long, usually drooping in fruit, at first ovoid-lanceolate, becoming somewhat oblong-lanceolate, *always acute*, mostly 5–9-flowered; empty glumes broad, smooth or scabrous, the lower 3–5-nerved, 5–6 mm. long, the upper broader, 5–7-nerved, 6–8 mm. long; flowering glume elliptical, smooth, or scabrous, 7-nerved, 6–8 mm. long, very shortly bidentate at the apex, with a straight awn 5–8 mm. long inserted about 1 mm. below the apex; *palea shorter than its glume.* Introduced from Europe.

Specimens examined.—*Cape Breton Island:* New Campbellton (D. White and Chas. Schubert 28). *Maine:* Foxcroft (M. L. Fernald 565). *Pennsylvania:* Bucks Co. (N. L. Britton); Philadelphia (C. E. Smith 41). *Delaware:* Centreville (A. Commons 137).

The validity of this species is uncertain. The only thing in Linnæus's original description to distinguish it from other closely related forms is the following: "Panicula constat racemo simplici: pedunculis alternis, sæpius solitarius . . . ."

We have for the present accepted the interpretation and emendation of the species as given by Mertens and Koch in "Rœhling's Deutschlands Flora 1^2: 681." These authors state that the growing plant shows the greatest resemblance to *B. mollis.* It differs from that species, however, in its smooth spikelets and looser panicle. From *B. secalinus* it is said to always differ in the fruiting condition in having the margins of the flowering glumes flat and overlapping, or but very slightly involute toward the base, instead of having the florets spread and the margins strongly involute. It is also said to flower earlier and have more pubescence on leaves and sheaths. Much of the material in the herbarium hitherto referred to this species belongs to *B. racemosus commutatus* and *B. secalinus*, and the western material especially is in great part *B. hordeaceus glabrescens*, which is distinguished by its denser panicle with shorter branches.

2*a*. **BROMUS RACEMOSUS COMMUTATUS** (Schrad.) Hook. f. Stud. Fl. Brit. Isl. 451. 1870. *Bromus commutatus* Schrad. Fl. Germ. 353. 1806. *Serrafalcus commutatus* Bab. Man. Brit. Bot. 374. 1843.

An annual or biennial, 3–7 dm. high, typically with a rather small panicle, but frequently, under favorable conditions of growth, with a panicle as large as that of *B. secalinus*, but more drooping. It differs from the species in its rather larger spikelets and panicle, also rather broader flowering glumes with frequently a faint indication of an angle on the margin just above the middle. The spikelets 2–2.5 cm. long, 6–7 mm. wide, intermediate in size between *B. racemosus* and *B. squarrosus;* from the latter it differs in its straight awn also. From *B. arvensis* it is separated by its smaller drooping panicle and larger spikelets.

This plant seems to be quite generally introduced throughout the country, and especially in the East.

Specimens examined.—*Massachusetts:* Essex Co. (Oakes). *Connecticut:* Fairfield (E. H. Eames). *New York:* Ithaca (F. V. Coville). *Pennsylvania:* Easton (T. C. Porter). *Maryland:* Marshall Hall (C. L. Pollard 303). *Ohio:* Oberlin (A. E. Ricksecker); Painesville (W. C. Werner). *Tennessee:* Knoxville (A. Ruth). *Michigan:* Agricultural College (C. F. Wheeler). *Iowa:* (L. H. Pammel 909). *Missouri:* Sheffield (B. F. Bush 599). *Washington:* Pullman (A. D. E. Elmer 886); near Montesano (A. A. & E. G. Heller 3983). *Oregon:* Otis Creek (J. B. Leiberg 2338).

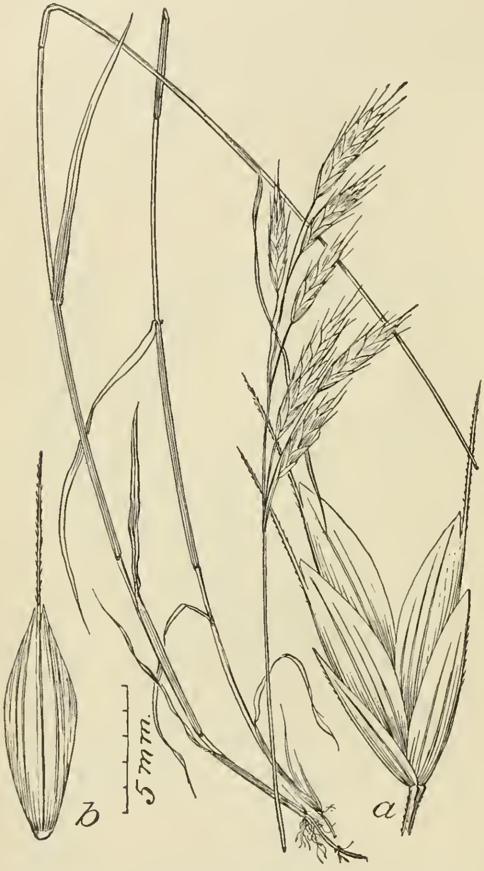

Fig. 2.—*Bromus racemosus: a*, lower portion of a spikelet; *b*, flowering glume, dorsal view.

3. **BROMUS HORDEACEUS** L. Sp. Pl. **1**: 77. 1753. *Bromus mollis* L. Sp. Pl. ed. 2. **1**: 112. 1762. *Serrafalcus mollis* Parl. Fl. Ital. **1**: 395. 1848. (Fig. 3.)

An erect or ascending annual or biennial *with a rather dense, erect panicle.* Culms about 2–8 dm. high, usually somewhat pubescent at the nodes. *Sheaths retrorsely soft pilose-pubescent;* ligule 1.5–2 mm. long, laciniate; blades linear, varying from pilose-pubescent to nearly smooth, about 5–15 cm. long and 3–5 mm. broad. *Panicle contracted*, narrow-pyramidal, 5–10 cm. long by 2–4 cm. broad; branches somewhat spreading in flower. Spikelets 5–13-flowered, ovate-lanceolate, *becoming obtuse*, 12–15 mm. long by 4–6 mm. wide, with short pedicels; empty glumes broad, obtuse, *coarsely pilose or scabrous-pubescent*, the lower 3–5-nerved, 4–6 mm. long, the upper 5–7-nerved, 7–8 mm. long; flowering glume broad, obtuse, 7-nerved, coarsely pilose or scabrous-pubescent, rather deeply bidentate, margin and apex hyaline, 8–9 mm. long; awn *rather stout*, rough, flattened toward the base, straight at first, *frequently somewhat twisted when old*, about 6–9 mm. long; palea a little more than $\frac{3}{4}$ the length of its glume.

A species native in southern Europe, introduced into this country, where it is very abundant on the Pacific coast, having taken possession of vast areas of the deteriorated semiarid range lands. It is also found sparingly on the Atlantic coast from Maine to Virginia.

Specimens examined.—*Maine:* N. Berwick (J. C. Parlin 567). *New York:* Aurora (F. V. Coville in 1885). *Pennsylvania:* Philadelphia (I. C. Martindale 13 and 14). *Delaware:* Centerville (A. Commons 133). *Ohio:* Oberlin (A. E. Ricksecker 1895). *Montana:* Garrison (P. A. Rydberg 2126). *Utah:* Ogden (T. A. Williams 2495). *Idaho:* Clear Water River (Sandberg, Heller, McDougal 167). *Washington:* Walla Walla (C. L. Shear 1585; E. P. Sheldon 8140); Tacoma (A. B. Leckenby in 1898); Cascade Mts. (G. R. Vasey in 1889; Sandberg & Leiberg 172); Seattle (C. V. Piper 796). *Oregon:* Lexington (J. B. Leiberg 10). *California:* San Francisco (M. E. Jones 3270); Marin Co. (Dr. E. Palmer 2032, 2033); Berkeley (J. W. Blankinship 64); Santa Cruz (Dr. Anderson in 1887); Morley Station (J. B. Davy 1894); San Jose (H. A. Brainard in 1896); Pitt River (H. E. Brown 224); Mt. Shasta (H. E. Brown 374b).

There being nothing in the original descriptions of these species to separate them, we have adopted the older name on the authority of Munro, who states in his paper on "The Grasses of Linnæus's Herbarium"[1] that Linnæus's specimens of the two, *B. hordeaceus* and *B. mollis*, are the same.

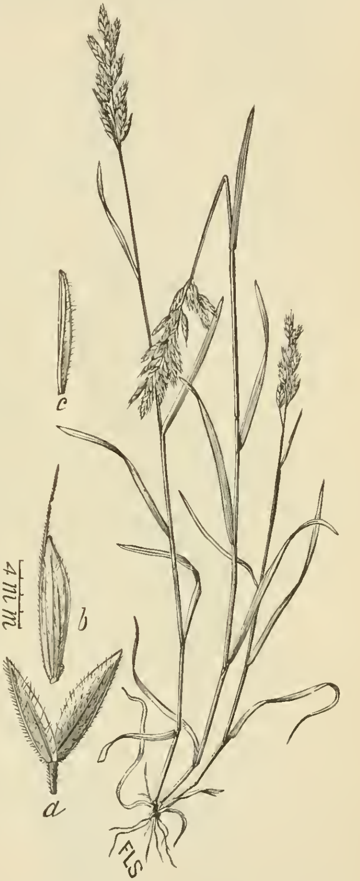

Fig. 3.—*Bromus hordeaceus:* *a*, empty glumes; *b*, flowering glume; *c*, palea.

3*a*. **BROMUS HORDEACEUS INTERMEDIUS** (Guss.) n. comb. *Bromus intermedius* Guss. Fl. Sic. Prod. **1** : 114. 1827. *Serrafalcus intermedius* Parl. Rar. Pl. Sic. **2** : 17. 1840.

This differs from the species only in its slightly larger panicle and spikelets and awns, which are twisted and divaricate when mature and dry.

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[1] Proceedings of the Linnæan Society—Botany, **6**: 46. 1861.

Represented in the herbarium by a single specimen collected by Dr. L. D. Morse along a walk in San Mateo, California, June, 1898.

3β. **BROMUS HORDEACEUS GLABRESCENS** (Coss.) n. comb. *Bromus mollis glabrescens* Coss. Fl. Descr. Par. 654. 1845.

This differs from the species in having the spikelets glabrous or only scabrous throughout.

Like the species it is introduced on the east and west coasts.

Specimens Examined.—*Delaware:* Millsboro (A. Commons 132). *District of Columbia:* N. E. Washington (F. Blanchard). *California:* Marin County (Dr. E. Palmer 2033); New York Falls (G. Hansen 2080); San Francisco (Bolander). *Oregon:* Bonneville (W. M. Canby 26). *Washington:* Pullman (A. D. E. Elmer 876); no locality (E. P. Sheldon 8205 and G. R. Vasey).

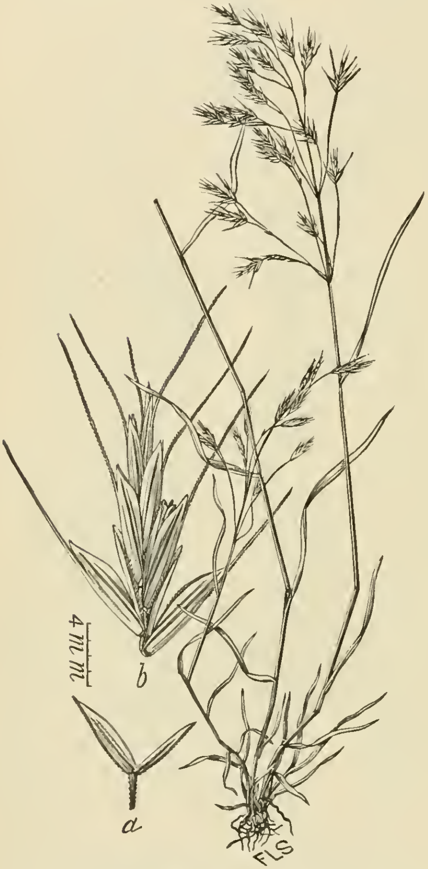

Fig. 4.—*Bromus arvensis:* *a*, empty glumes; *b*, part of a spikelet with the lower florets open showing the paleæ.

4. **BROMUS ARVENSIS** L. Sp. Pl. **1**: 77. 1753. *Serrafalcus arvensis* Parl. Fl. Ital. **1**: 393. 1848. (Fig. 4.)

A tufted annual or biennial, somewhat geniculate at the base. Culm nearly or quite glabrous, about 3–6 dm. high. *Sheaths densely soft pubescent;* ligule about 2 mm. long, lacerate; blades linear, pubescent both sides. Panicle effuse, broad, apex somewhat drooping; *lower rays mostly 4–8.* Spikelets terete-acuminate at first, becoming slightly laterally compressed when old, about 7–11-flowered, 1.5–2.5 cm. long, 3–4 mm. broad, smooth or minutely scabrous throughout; empty glumes broad; the lower subacute 3–5-nerved, 4–5 mm. long; the upper about 7-nerved, obtuse, 5–6 mm. long; flowering glume 7–8 mm. long, broad, *obtuse with the broad hyaline margin projecting slightly into an obtuse angle just above the middle;* apex hyaline, emarginate; awn inserted below the apex, 7–10 mm. long, *straight or slightly twisted when old;* palea shorter than its glume.

Type from Europe.

Introduced into this country in a few localities. Dr. Beal, in "Grasses of North America," reports it from New Jersey and Michigan. The only American specimens we have seen are the following: *Missouri:* Sheffield, common along railroads (B. F. Bush 577 and 588).

This can scarcely be satisfactorily separated from *B. patulus* M & K., which see for the points of difference usually noted. It is also close to *B. racemosus commutatus.*

5. **BROMUS PATULUS** M. & K. in Roehl. Deutsch. Fl. **1**: 684. 1823. *Serrafalcus patulus* Parl. Fl. Ital. **1**: 394. 1848. (Fig. 5.)

An annual or biennial with culms smooth, erect, or somewhat geniculate at the base, about 4–6 dm. high. Sheaths softly pubescent; ligule 2–3 mm. long, subtruncate, laciniate-dentate; blades linear-lanceolate, pubescent throughout. Panicle 12–20 cm. long, very broadly pyramidal, diffuse, somewhat drooping; *lower branches 3–5*, slender, smooth; spikelets on slender pedicels, drooping, lanceolate to ovoid-lanceolate, terete at first, 2–2.5 cm. long, 5–6 mm. broad, becoming somewhat laterally compressed at maturity, smooth throughout; empty glumes rather broad, the lower narrower, acute, 3-nerved, 4–6 mm. long; the upper obtuse, *5-nerved, 6–8 mm. long;* flowering glume 9-nerved, the marginal ones faint, 7–9 mm. long, broad, obtuse, *with a hyaline margin obtusely angled above the middle and an emarginate apex;* awn 8–10 mm. long, stout, *somewhat twisted and strongly divaricate at maturity,* inserted below the apex; palea conspicuously shorter than its glume.

Type from Austria.

Introduced in this country in a few places.

Specimens examined. — *Massachusetts:* waste ground, Boston (C. W. Swan). *South Dakota:* Brookings (T. A. Williams). *Colorado:* Fort Collins (L. H. Pammel).

A species intermediate between *B. arvensis* and *B. squarrosus.* From the former it is distinguished by its somewhat larger, more compressed spikelets, rather stouter awn, strongly divergent at maturity, and earlier flowering period. From the latter it is distinguished by its narrower spikelets, larger panicle, and less conspicuous angle at the margin of the flowering glume. Perhaps but a variety of *B. arvensis.*

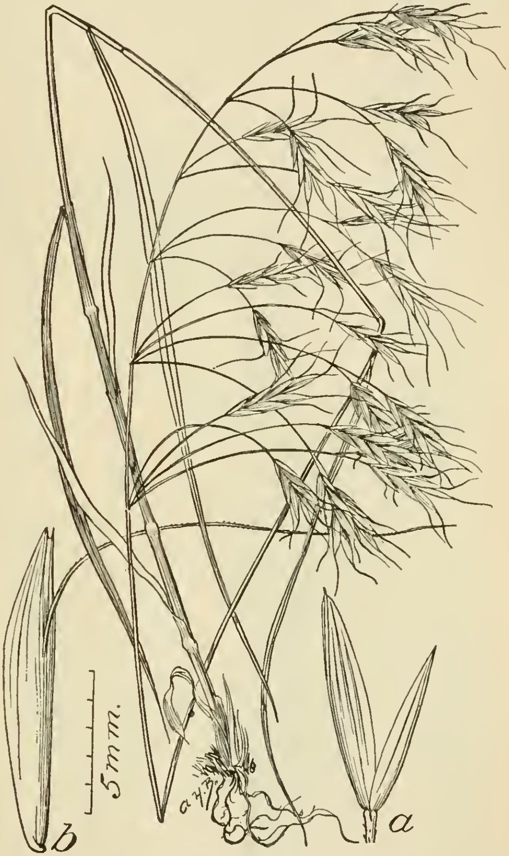

Fig. 5.—*Bromus patulus:* *a*, empty glumes; *b*, flowering glume.

6. **BROMUS SQUARROSUS** L. Sp. Pl. **1**: 76. 1753. *Serrafalcus squarrosus* Bab. Man. Brit. Bot. 375. 1843. (Fig. 6.)

A more or less tufted annual, 2–4 dm. high with a short, somewhat nodding panicle and densely soft pilose sheaths. Culms erect or slightly geniculate at the base, smooth. Sheaths densely retrorsely pilose-pubescent; ligule about 1 mm. long; blades linear, about 8–15 cm. long, 3–5 mm. wide, softly pubescent on both sides. Panicle *usually 6–12 cm. long,* open, branches ascending or drooping, frequently flexnous. Spikelets oblong to oblong ovoid, turgid, 6–12-flowered, 15–20 mm. long; empty glumes broad, obtuse, glabrous, the lower 3- or indistinctly 5-nerved, $\frac{2}{3}$–$\frac{3}{4}$ the length of the upper, the upper 7–9-nerved, 6–8 mm. long; flowering glume *very broad, 7–9-nerved, obtuse,* with a broad scarious margin somewhat obtusely angled above the middle, glabrous or minutely scabrous, apex minutely notched; awn *rather stout, attached below the apex,* about the length of the glume, *somewhat twisted and divergent, especially at maturity;* palea a little shorter than its glume.

Adventive from Europe. Has been found in waste places on the eastern coast sec. Britton and Brown, "Illustrated Flora."

Type in Linnæus's herbarium.

SPECIMENS EXAMINED: A single specimen in the National Herbarium collected at Lansingburg, New York, by Dr. E. C. Howe in 1886, has been referred to this species, though it is not typical but approaches very closely *B. secalinus* and *arvensis.*

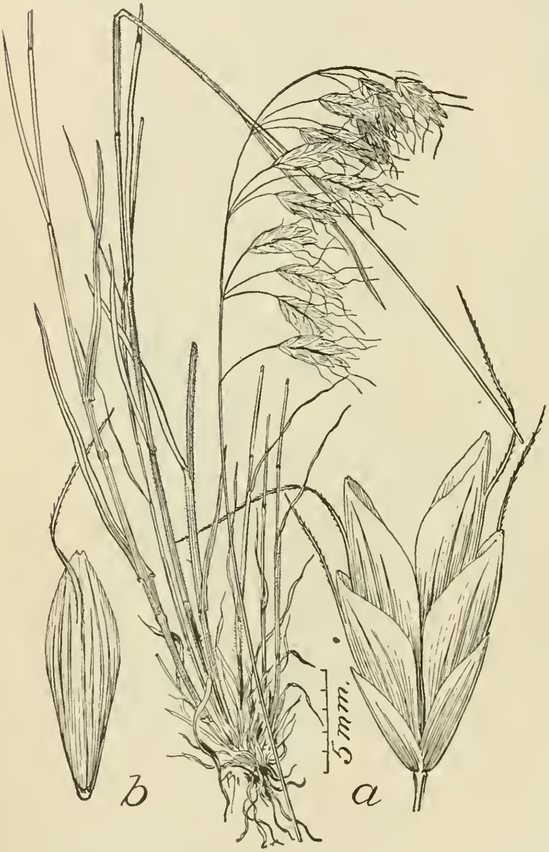

FIG. 6.—*Bromus squarrosus:* *a*, lower portion of a spikelet; *b*, dorsal view of a flowering glume.

7. **BROMUS BRIZÆFORMIS** Fisch. & Mey. Ind. Sem. Hort. Petrop. **3**: 30. 1837. (Fig. 7.)

An erect annual with rather slender culms and *large drooping, brizæform spikelets.* Culms about 3–6 dm. high, smooth or slightly pubescent at the nodes. Sheaths with a soft, short-pilose pubescence, especially the lower ones; ligule about 2 mm. long, somewhat laciniate; blades linear, usually pubescent on both sides. Panicle 5–25 cm. long, lax, secund, mostly nodding. *Spikelets about 15–25 mm. broad,* oblong-ovoid, *laterally much compressed;* empty glumes broad, obtuse, smooth or minutely scabrous, frequently purplish, lower 3–5-nerved, about one-half the length of the upper, which is broader, 5–9-nerved and 6–8 mm. long; flowering glume about 1 cm. long, *very broad,* obtuse, smooth or slightly scabrous, with a broad scarious margin; awn none or sometimes present, especially on the upper flowering glumes, terminal, 1–2 mm. long; palea not quite equaling the glume, sparsely pectinate-ciliate on the keels.

Introduced. Most frequently met with on the west coast.

Type locality "in montibus Talüsch." (Caucausus Region?)

SPECIMENS EXAMINED.—*Massachusetts* (ex herb. W. P. Alcott in 1880). *New York:* Ithaca (W. R. Dudley in 1884). *Delaware:* Wilmington (A. Commons 339 in 1898). *Montana:* (F. Lamson-Scribner 97 in 1883). *Idaho:* Lewiston (A. A. & E. G. Heller 3203 in 1896; L. F. Henderson 4635 in 1894); Viola (Sandberg, Heller & McDougal 482 in 1892); Cœur d'Alene Mountains (J. B. Leiberg 1006 in 1895). *Utah:* Echo (P. A. Rydberg 2353 in 1895); Salt Lake City (L. H. Pammel 197 in 1899). *Nevada:* Reno (S. M. Tracy 194 in 1887). *Washington:* Waitsburg (R. M. Horner 563 in 1897); Pullman (A. D. E. Elmer 371 in 1896; 876 in 1897); Wawawai (C. V. Piper 1739 in 1894). *Oregon:* Prineville (J. B. Leiberg 308 in 1894). *California:* Near Mount Shasta (Dr. E. Palmer 2647 in 1892).

8. **BROMUS SCOPARIUS** L. Cent. Pl. **1**: 6. 1755. *Serrafalcus scoparius* Parl. Fl. Pal. **1**: 174. 1845. (Fig. 8.)

An annual with rather slender, smooth, nearly erect culms about 2–3 dm. high. Sheaths sparsely pilose or nearly smooth; ligule about 1 mm. long, laciniate-dentate; blades linear, 6–12 cm. long, mostly pilose above and smooth beneath. Panicle *dense, oblong or ovate, obtuse, erect, 3–6 cm. long, 1–3 cm. broad;* branches *very short.* Spikelets very short-pedicellate, oblong-lanceolate, 5–11-flowered, 10–18 mm. long; empty glumes glabrous or slightly scabrous on the nerves, the lower acute, 1–3-nerved, 4–5 mm. long, the upper 3-nerved, broader, 5–6 mm. long; flowering glume 7–8 mm. long, 5-nerved, varying from typically smooth to sometimes scabrous-pubescent, bidentate at the membranous apex; *awn twisted, divaricate, 7–8 mm. long inserted 1.5–2 mm. below the apex;* palea about 1 mm. shorter than its glume with the keels remotely ciliate-pectinate.

Type from Spain.

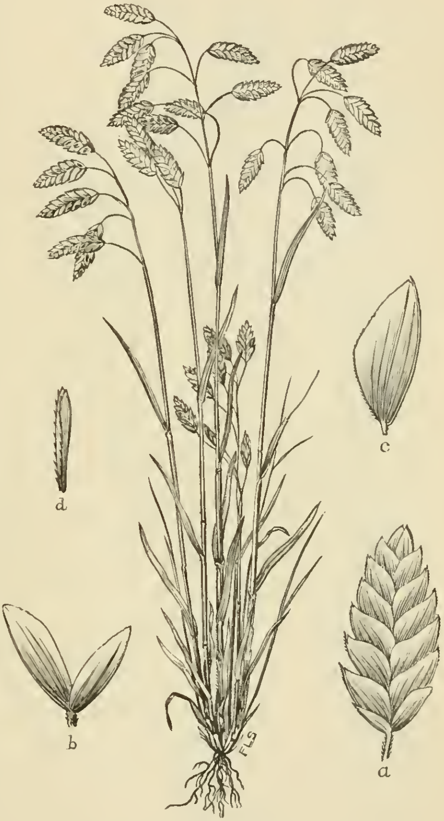

FIG. 7.—*Bromus brizæformis: a*, a spikelet; *b*, empty glumes; *c*, flowering glume; *d*, palea.

Indigenous in the Mediterranean region of Europe and Africa, adventive in California.

We have only one specimen in the herbarium, collected by J. W. Congdon, at Mariposa, California.

II. NEOBROMUS n. subgen.

Flowering glumes lanceolate, deeply bifid; awn twisted and bent below the middle.

The following species is the type of this subgenus:

9. **BROMUS TRINII** Desv. in Gay Fl. Chil. **6**: 441. 1853. *Trisetum hirtum* Trin. Linnæa, **10**: 300. 1835. Not *B. hirtus* Lichtst. 1817. *Trisetum barbatum* Steud.

Syn. Pl. Gram. 229. 1854. *Bromus barbatoides* Beal, Grass. N. A. **2**: 614. 1896. *Avena symphicarpi* Trin. mss. (p. p.) sec. Desvaux l. c.. (Fig. 9.)

An erect caespitose annual, usually branching below, mostly 3–6 dm. high. Culm smooth or pubescent at the nodes. Sheath usually pilose-pubescent, sometimes nearly smooth; ligule rounded or subtruncate, dentate, about 1 mm. long; blades linear to linear-lanceolate, 6–15 cm. long, 3–5 mm. wide, mostly pilose-pubescent throughout, sometimes nearly smooth. Panicle usually narrow and somewhat crowded, suberect, 8–20 cm. long; branches rather numerous, slender, ascending or diverging in fruit. Spikelets narrow, lanceolate at first, becoming spread and oblong lanceolate in flower and fruit, *mostly 5–7-flowered*, 1.5–2 cm. long; empty glumes lanceolate, acuminate, or with a subulate prolongation, smooth, the lower 1-nerved, rarely 3-nerved, 8–11 mm. long, the upper broader, 3-nerved, rarely 5-nerved, 13–16 mm. long; flowering glume *coarsely and subsparsely pubescent*, 5-nerved, 12–15 mm. long, *acuminate, with two narrow teeth 2–3 mm. long;* the pubescence on the callus is usually slightly denser and longer than on the glume; awn *15–20 mm. long, twisted below, bent below the middle and strongly divaricate when old.*

Type from Chile.

General distribution: California to Colorado and south to Chile.

Specimens examined.—*Utah:* Sitgreaves Pass, Camp 60 (Ives Expedition). *Nevada:* Near Horse Spring (M. E. Jones 5069f); valley of Virgin River, Lincoln County (Coville & Funston 1907). *California:* Los Angeles (S. M. Tracy 163; Kellogg & Harford 1087, 1094); near Pasadena (O. D. Allen, April 12, 1885); Panamint Mountains, Inyo County (Coville & Funston 506); near San Francisco (Bolander 6128).

This plant is apparently related to *B. scoparius* and *B. tectorum*, though differing in some respects from all species of *Bromus* and showing close relationship with *Trisetum* and *Avena*, to both of which genera forms of it have been referred. It appears to us, however, nearest to *Bromus* by reason of its rather large numerous flowered spikelets, nearly closed sheath, and plicate grain adhering to the palea.

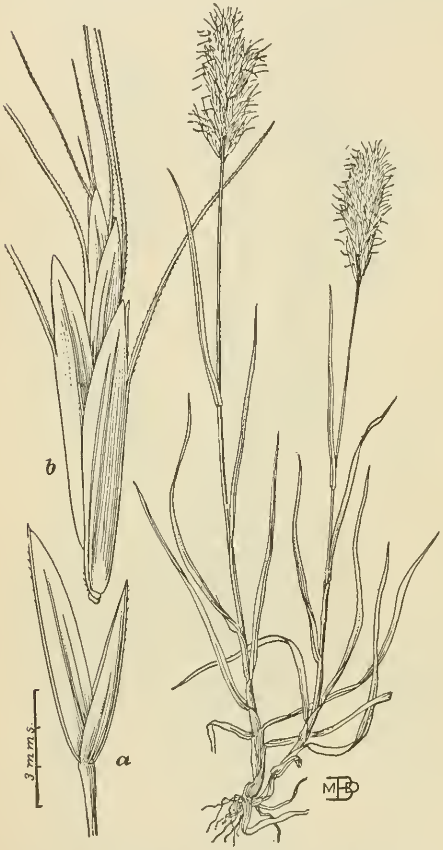

Fig. 8.—*Bromus scoparius: a*, empty glumes; *b*, portion of a spikelet, showing flowering glumes.

9*a*. **BROMUS TRINII PALLIDIFLORUS** Desv. in Gay Fl. Chil. **6**: 441. 1853. *Bromus barbatoides sulcatus* Beal, Grass. N. A. **2**: 615. 1896. *Trisetum barbatum major* Vas. in herb. and Beal l. c.

A more robust and larger plant, 6–12 dm. high, with a much elongated panicle mostly 2–4 dm. long; with branches mostly 6–12 at the lower whorls, weak and spreading; leaves broadly linear lanceolate, smooth or somewhat sparsely pilose-pubescent, as are also the sheaths.

Type from the Andes of southern Chile.

General distribution: Southern California to southern Chile.

Specimens examined.—*California:* Near Pasadena (O. D. Allen in 1885); Chollos Valley, San Diego (C. R. Orcutt 1064); San Diego (D. Cleveland in 1882); San Nicholas Island (Blanche Trask 15).

9β. BROMUS TRINII EXCELSUS n. var.

A stout perennial (?) 5–7 dm. high. Leaves and sheaths short pilose-pubescent. Panicle rather narrow, nearly erect 1.5–2 dm. long; branches numerous, ascending, 2–8 cm. long. Spikelets *oblong-lanceolate, carinate,* 2–2.5 cm. long, *5–6 mm. wide;* empty glumes lanceolate-acuminate, smooth, the lower 3-nerved, 13–15 mm. long; flowering glume *7-nerved, 10–12 mm. long,* sparsely pilose-pubescent, bidentate at the acute apex; teeth 1–2 mm. long; *awn 10–12 mm. long,* somewhat twisted at the base, and divaricate.

Type No. 522, collected by Coville & Funston in the Panamint Mountains, Inyo County, California; altitude 1,700 m.

This plant, which is the only one of this form seen, is somewhat anomalous and may prove to be a good species. The spikelets and glumes are conspicuously wider than in the species, the florets more crowded, and the awn shorter.

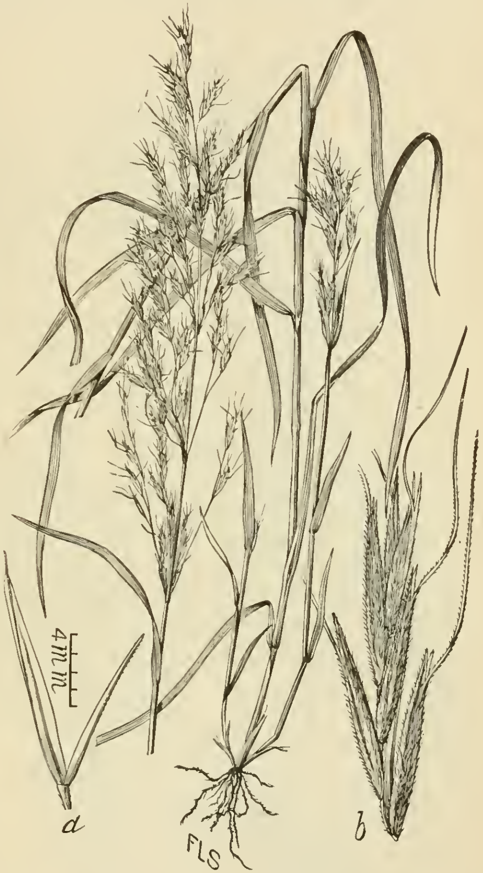

Fig. 9.—*Bromus trinii:* *a,* empty glumes; *b,* portion of a spikelet showing flowering glumes.

III. STENOBROMUS Griseb.

Annual or biennial plants, with mostly narrow spikelets and glumes and rather long awns. Chiefly natives of the Mediterranean region of Europe and Africa. Introduced in this country.

10. BROMUS MADRITENSIS L. Cent. Pl. 1 : 5. 1755. (Fig. 10.)

A tufted annual, with an erect, rather dense panicle. Culm 3–7 dm. high, erect or somewhat geniculate at the base, smooth. Sheaths smooth or the lower slightly pubescent; ligule about 2 mm. long, subtruncate and lacerate; blades linear, puberulent or nearly smooth, 5–15 cm. long, 2–4 mm. wide. Panicle *erect, 5–12 cm. long, oblong-ovoid in outline,* lower branches 2–4, 1–3 cm. long, unequal, somewhat spreading in flower, slender and somewhat swollen at the base of the spikelets. Spikelets *3–4 cm. long* exclusive of awns, nearly smooth to scabrous-puberulent, 7–11 flowered; empty glumes lanceolate, acuminate, the lower 1-nerved, 9–12 mm. long, the upper 3-nerved, 13–16 mm. long; flowering glume linear-lanceolate, *15–18 mm. long*, usually glabrous or merely scabrous, somewhat curved outward when old, distinctly 3 or faintly 5–7-nerved, with two acute hyaline teeth, 2–3 mm. long, *and a rather stout, tapering, rough, somewhat curved awn about 16–22 mm. long;* palea reaching about to the point of the insertion of the awn, pectinate-ciliate on the keels.

A species introduced from Europe rather widely distributed in California and reported from Michigan by Beal in "Grasses of North America."

Specimens examined.—*California:* San Jose (H. A. Brainard); near Antioch (J. Burtt Davy 111); Ft. Tejon (S. B. Parish 1994); New York Falls, Amador County (Geo. Hansen 2123).

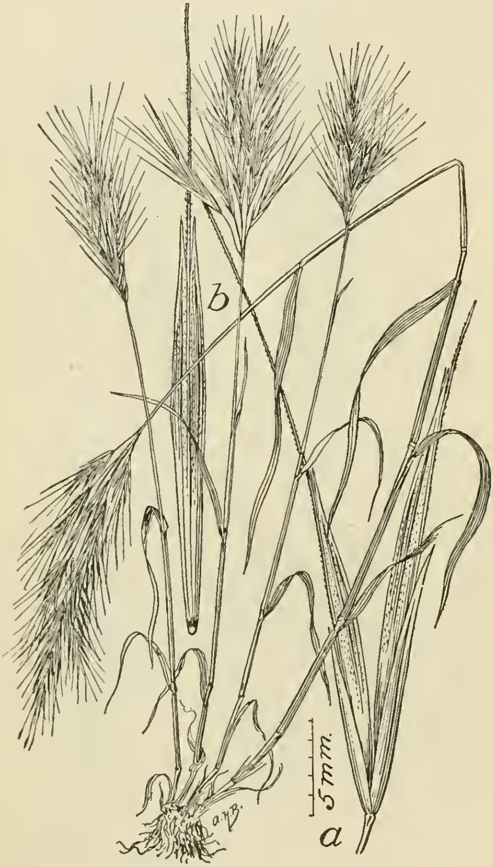

Fig. 10.—*Bromus madritensis: a*, empty glumes and two lower florets; *b*, flowering glume with part of the awn.

11. **BROMUS MAXIMUS** Desf. Fl. Atl. **1**: 95. *t. 26.* 1798. (Fig. 11.)

An erect or ascending annual, 2–4 dm. high, with a smooth culm. Sheaths pilose-pubescent; ligule 3–4 mm. long, rounded above, lacerate; blades flat, linear, 3–5 mm. broad and about 2–3 dm. long, pilose both sides. Panicle erect, somewhat secund and narrow, open in flower, closing more or less afterwards, 5–10 cm. long, lower branches 2–3, about 1.2 cm. long, bearing 1–2 spikelets. Spikelets *usually 5–7-flowered*, 3.5–5 cm. long, exclusive of the awns, terete or somewhat laterally compressed at maturity; empty glumes smooth, lanceolate, acuminate, the lower 15–20 mm. long, strongly 1-nerved, margin hyaline, the upper broader, 25–30 mm. long, prominently 3-nerved; flowering glume 5-nerved, *25–30 mm. long*, harshly scabrous to scabrous-puberulent, 2-toothed at the apex; teeth hyaline, acute, about 3–4 mm. long, awn *stout, 3.5–4.5 cm. long*, very rough, tapering toward the end, inserted just below the teeth; palea somewhat shorter than its glume; rachilla slender, puberulent, about 3 mm. long.

Type from northern Africa

Specimens examined.—*California:* Stanford University (C. Ritter 305); (J. B. Davy in 1894).

There are several names antedating the above which are regarded by some European authorities as synonymous. *B. rigidus* Roth, Roem. & Ust. Mag. Bot. **10**: 21. 1790 is one. This has been adopted by Dr. Beal (Grass. N. A. **2**: 611. 1896). A careful study of the original description of this species, however, leads us to believe that the plant should at least be separated as a variety. The following quotations from Roth's description l. c. indicate the chief points of difference: "Culmi . . primus erecti, demum procumbentes, panicula . . spiculis . . 10 ad 12 floribus compositis; corollæ valvula exterior . . hirsuta."

The most important difference between our plants as well as the European specimens examined and the above description is in the hirsute flowering glume. Mertens and Koch in Roehl. Deutsch. Fl. **1**: 689. 1823, say that they received a specimen from Roth himself having smooth spikelets, thus showing that he regarded such forms as belonging to his species. Notwithstanding this these authors, l. c., p. 691, regard *B. maximus* as at least varietally separate from *B. rigidus*, so it seems to us best to retain for the present for our plant Desfontaine's name. *Bromus incrassatus* Lam. Enc. **1**: 468. 1783, and *B. rigens* L. Mant. **1**: 33. 1767, are also doubtful synonyms.

11*a*. BROMUS MAXIMUS GUSSONI Parl. Fl. Ital. **1**: 407. 1848. *Bromus gussoni* Parl. Rar. Pl. Sic. **2**: 8. 1840. *Bromus sterilis* Guss. Fl. Sic. Prod. Suppl. **1**: 27. 1832. Not L. 1753.

Differs from the species in its larger size, 4–7 dm. tall, larger and more lax panicle, 1–2 dm. long, with the upper part somewhat drooping.

An introduced plant occurring in Arizona, California, and Washington.

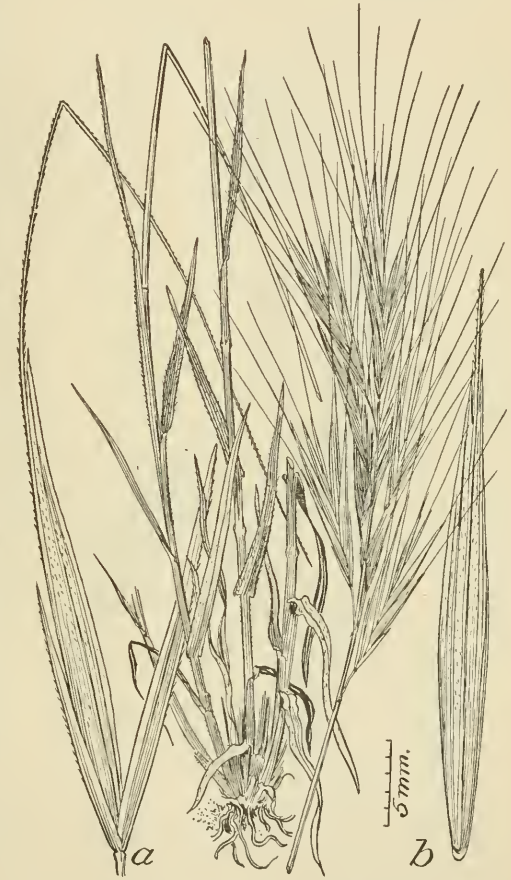

Fig. 11.—*Bromus maximus*: *a*, empty glumes with a floret; *b*, flowering glume with portion of the awn.

Specimens examined.—*Arizona:* Near Fort Huachuca (T. E. Wilcox 172); Huachuca Mt. (J. G. Lemmon and wife 3107). *California:* Avalon, Santa Catalina Island (Blanche Trask in 1898); San Francisco (Bolander); San Jose (H. A. Brainard, in 1896); San Diego (C. R. Orcutt 1059); Woodland (J. W. Blankinship 39 and 40); Berkeley County (J. W. Blankinship 38); Clear Creek, Butte County (H. E. Brown 199); Chico (E. Palmer 2034); New York Falls, Amador County (G. Hansen 598); near San Bernardino (J. B. Leiberg 3323). *Washington:* Tacoma (A. B. Leckenby in 1898).

12. **BROMUS RUBENS** L. Cent. Pl. **1**: 5. 1755. *Festuca rubens* Pers. Syn. Pl. **1**: 94. 1805. (Fig. 12.)

A rather slender, tufted annual. Culm about 2–5 dm. high, erect or slightly geniculate at the base, puberulent toward the top. Sheaths pubescent, ligule 1–2 mm. long, laciniate-dentate; blades 3–15 cm. long, linear-lanceolate, pubescent both sides. Panicle *erect, compact, ovoid, usually purplish, about 4–7 cm. long.* Spikelets mostly 7–11-flowered, *2–2.5 cm. long;* empty glumes acuminate, smooth to scabrous, pubescent, the lower narrow, 1-nerved, 7–9 mm. long, the upper broader, 3-nerved, 10–12 mm. long; flowering glume *13–16 mm. long*, lanceolate acute, 5-nerved, scabrous to appressed, scabrous-pubescent, somewhat bent outward when mature, *apex deeply cleft into two long-acuminate hyaline teeth 4–5 mm. long; awn straight, 18–21 mm. long;* palea reaching about to the point of insertion of the awn, long ciliate-pectinate on the keels.

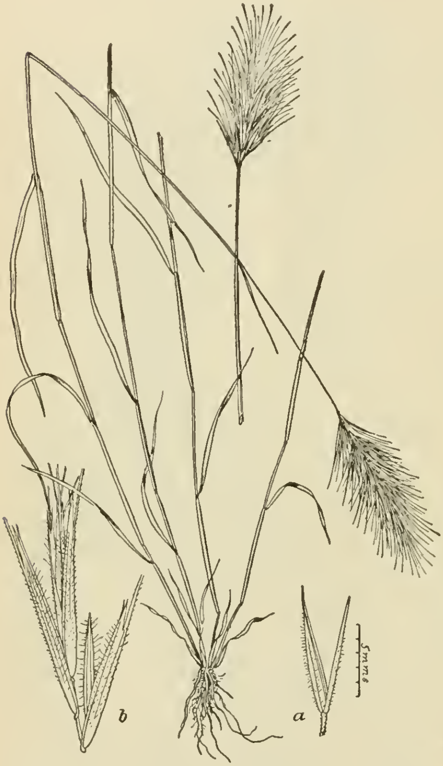

Fig. 12.—*Bromus rubens:* *a*, empty glumes; *b*, portion of a spikelet showing flowering glume with portion of the awn, also the palea.

A species from the Mediterranean region of Europe introduced on the Pacific coast and reported by Beal as being found in Kansas. A single specimen has been seen from the Atlantic coast on wool waste near Boston, Mass.

Specimens examined.—*California:* Volcano, Amador County (George Hansen 2078); near Santa Ana (A. Davidson 1973); Santa Catalina Island (Blanche Trask 12; T. A. Brandegee); Berkeley (J. W. Blankinship 36); Capay (J. W. Blankinship 37). *Oregon:* Gilliam County (J. B. Leiberg 163). *Massachusetts:* N. Billerica (C. W. Swan).

This species is closely related to *B. madritensis*, but is smaller throughout and has a more compact panicle.

13. **BROMUS STERILIS** L. Sp. Pl. **1**: 77. 1753. *Schedonorus sterilis* Fr. Summ. Veg. Scand. **1**: 76. 1846–49. (Fig. 13.)

An annual or biennial with rather stout, smooth, erect or ascending culms, 5–10 dm. high, more or less geniculate or curved at the base. Sheaths mostly pubescent; ligule 1–1.5 mm. long, laciniate; blades broadly linear, usually pubescent throughout. Panicle *1–2 dm. long, broad, lax, drooping; lower branches 2–6*, long and slender, rarely bearing more than one spikelet. Spikelets *drooping, 2.5–3.5 cm. long*, 6–10-flowered, linear-elliptical before flowering, becoming oblong and enlarged upward during flowering, and finally oblong-cuneiform with flattened sides and subdistant florets; empty glumes lanceolate-subulate, smooth or scabrous, the lower 1-nerved, 7–9 mm. long, the upper 3-nerved, 11–13 mm. long; flowering glume *linear-lanceolate, 5–7-nerved, 17–20 mm. long*, scabrous or scabrous-puberulent, deeply bidentate; teeth hyaline, subulate, about 2 mm. long; awn *stout, tapering, very rough, 2–3 cm. long;* palea considerably shorter than its glume.

A species introduced from southern Europe, quite frequent on the Atlantic and Pacific coasts.

Specimens examined.—*Massachusetts:* Boston (C. W. Swan). *New York:* Taughannock (K. M. Wiegand; F. V. Coville). *Pennsylvania:* Easton (A. P. Garber; T. C. Porter); Philadelphia (C. E. Smith 40). *Delaware:* Wilmington (A. Commons 17). *District of Columbia:* North Brookland (T. Holm). *Ohio:* Painesville (W. C. Werner). *British Columbia:* Vancouver Island (J. Macoun 117). *Washington:* Pullman (C. V. Piper 2554); Walla Walla (C. L. Shear 1616).

14. **BROMUS TECTORUM** L. Sp. Pl. **1**: 77. 1753. *Schedonorus tectorum* Fr. Summ. Veg. Scand. **1**: 76. 1846–49. (Fig. 14.)

A tufted annual mostly 3–6 dm. high, erect or somewhat geniculate at the base. Culm smooth, rather slender. Sheaths pubescent; ligule membranous, 2–3 mm. long, much torn; blades linear, narrow, mostly pubescent throughout. Panicle *broad, rather dense, secund, drooping, about 6–15 cm. long, branches subcapillary.* Spikelets nodding, linear at first, spreading above in flower and becoming cuneiform, *13–20 mm. long;* empty glumes acute, scabrous or pubescent, the lower narrow, 1-nerved, 4–6 mm. long, the upper 3-nerved, broader, 8–10 mm. long; flowering glume lanceolate, acute, scabrous-pubescent to short pilose-pubescent, 5-nerved, 11–13 mm. long with two narrow hyaline teeth at the apex and *a straight awn about 13–15 mm. long;* palea shorter than its glume.

A species from Europe quite generally distributed in this country, especially in waste places about cities.

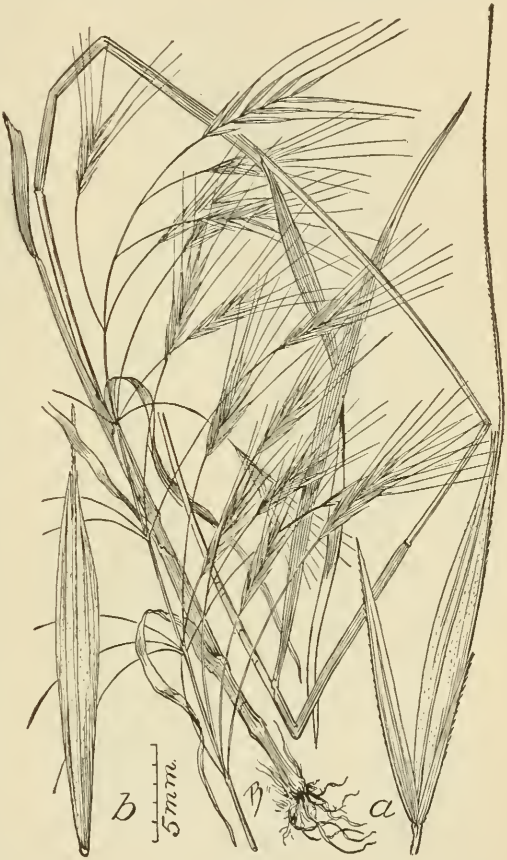

Fig. 13.—*Bromus sterilis:* *a*, Empty glumes and a floret; *b*, dorsal view of a flowering glume with portion of the awn.

Specimens examined.—*Massachusetts:* Cambridge (J. W. Blankinship; A. K. Harrison 28); Essex County (W. P. Conant). *Rhode Island:* Providence (J. F. Collins). *New Jersey:* Weehauken (Wm. N. Van Sickle). *Pennsylvania:* Easton (T. C. Porter). *Delaware:* Wilmington (A. Commons 16). *District of Columbia:* Washington (C. L. Pollard 426). *Virginia:* Alexandria (T. Holm). *Indiana:* Pine (L. M. Umbach). *Mississippi:* Starkville (S. M. Tracy 1746). *Colorado:* Fort Collins (E. D. Ball; C. S. Crandall 526). *Utah:* Ogden (T. A. Williams 2496); Provost (M. E. Jones 5503). *Washington:* (Sandberg & Leiberg 191); Pasco (A. D. E. Elmer 1047).

This species is nearly related to *B. sterilis*, but is much smaller in every way and has a denser panicle.

IV. ZERNA Panz. emend.

Nearly all native short-lived perennials, with but few exceptions, having a weak drooping panicle and more or less pubescent flowering glumes, frequently with the pubescence unevenly distributed.

A. *Panicle lax and drooping.*

15. BROMUS RAMOSUS Huds. Fl. Angl. ed. 1. 40. 1762. *Bromus asper* Murr. Prod. Stirp. Gött. 42. 1770. (Fig. 15.)

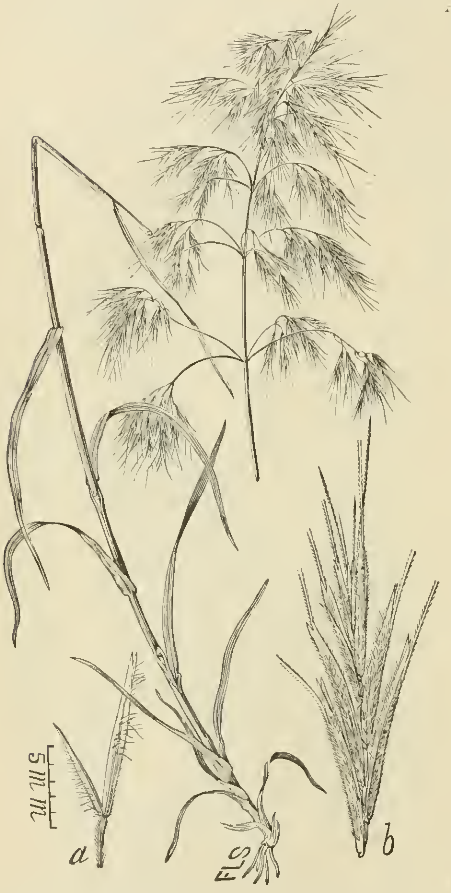

FIG. 14.—*Bromus tectorum*: *a*, Empty glumes; *b*, portion of a spikelet showing flowering glumes and portion of the awns.

A rather stout, erect, loosely cæspitose perennial with a rather long, loose, nodding panicle. Culms about 10–15 dm. high, smooth or slightly rough pubescent just below the nodes, rather slender. Sheaths shorter than the internodes, *clothed with abundant, rather stiff subretrorse hairs;* ligule *about 2 mm. long*, laciniate; blades broadly linear, about 2–3 dm. long and 8–12 mm. wide, sparsely pilose on the nerves beneath, harshly scabrous or subpilose above. Panicle 2–3 dm. long, open, loose, the branches distant, usually drooping. Spikelets about 6–10-flowered, narrow, *2–3 cm. long;* empty glumes narrow, scabrous on the nerves, lower 1-nerved, a little more than one-half the length of the upper, upper 3-nerved, acute or mucronate, 9–11 mm. long; flowering glume *12–15 mm. long*, acute, two-toothed at the apex, scarious margined, distinctly 3-nerved, *scabrous on the nerves*, shortly hispid from the outer nerves to the margin and on the lower portion of the keel; awn slender, straight, *7–9 mm. long;* palea *a little more than three-fourths the length of its glume*, ciliate-pectinate on the keels.

A species introduced from Europe. It is said in Britton and Brown's "Illustrated Flora" to be distributed from New Brunswick to Michigan and Kentucky. We have no American specimens in the National Herbarium, and have drawn the above description from European material. Dr. H. Trimen (Journ. Bot. **8**: 376. 1870) has been followed in adopting Hudson's name for this plant, which does not seem to have been different from Murray's. (Cf. Dr. Trimen l. c. for further synonymy.)

This species is very closely related to *B. ciliatus* and has possibly been confused with it. It is usually distinguished by its rougher pilose-hispid sheaths and longer flowering glume and awn. The panicle is usually looser and with fewer spikelets.

16. **BROMUS CILIATUS** L. Sp. Pl. **1**: 76. 1753. *Bromus canadensis* Mx. Fl. Bor. Am. **1**: 65. 1803. (Fig. 16.)

A tall, rather slender, leafy perennial with a broad, lax, drooping panicle. Culms erect, smooth or slightly pubescent at the dark nodes, about 7–12 dm. high. Sheaths retrorsely short-pilose or nearly smooth, coarsely striate; ligule *very short, rarely exceeding 1 mm.;* blades *rather broadly linear-lanceolate*, weak, about 2.5–3.5 dm. long and 1 cm. broad, *typically sparsely pilose on both sides*, but sometimes almost smooth. Panicle very broadly pyramidal, about 1.5–2.5 dm. long; lower branches 2–4 long, slender, flexuous, drooping. Spikelets narrow, 5–9-flowered, 15–22 mm. long on slender, flexuous pedicels; empty glumes narrow, smooth; the lower 1-nerved, acute, 5–8 mm. long; the upper broader, obtuse, 8–11 mm. long, 3-nerved; flowering glumes narrow, oblong-lanceolate, obtuse and slightly bifid at the apex, distinctly 3 or faintly 5–7-nerved, *ciliate-pubescent on each side from the outer nerve to the margin for about three-fourths the length, 10–12 mm. long;* awn slender, straight, 3–5 mm. long; palea narrow, nearly equaling the glume; rachilla slender, thinly pubescent.

General distribution: Newfoundland to New York, west to Manitoba and Minnesota.

Type grown at Upsala, Sweden, from seed sent from Canada by Kalm.

Specimens examined.— *Newfoundland:* Shoal Point (A. Waghorne 49); Chimney Cove (A. Waghorne 48); Exploits River (Robinson and Schrenk in 1894). *Northwest Territory:* Severn River (J. M. Macoun in 1886). *Manitoba:* Brandon (J. M. Macoun 13042). *Maine:* East Auburn (E. D. Merrill 18, 24, 33, 34); ex herb. M. S. C. (Jackman 6); Van Buren (M. L. Fernald 195); Cape Elizabeth (E. E. Gayle 873). *New Hampshire:* Jaffrey (B. L. Robinson 336). *Vermont:* Manchester (M. A. Day 214, 217). *Massachusetts:* Ipswich (Oakes). *New York:* McKenzie Pond (C. H. Peck 9); South Branch (F. Tweedy in 1879); (W. R. Dudley in 1884); Lebanon Springs (A. K. Harrison 44); Oriskany (Geo. Vasey in 1841). *Michigan:* Keweenaw Point (F. E. Wood 3515); Rochester (O. A. Farwell 536a—a small form). *Wisconsin:* Tomahawk (L. S. Cheney 2198). *Minnesota:* (F. F. Wood 1889).

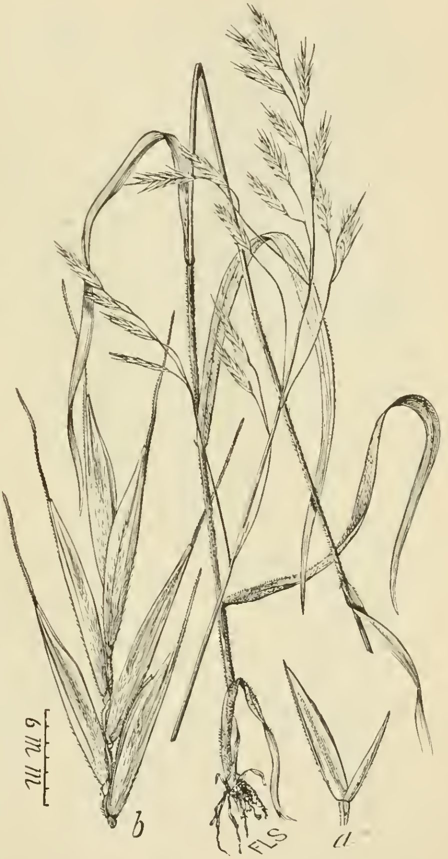

Fig. 15.—*Bromus ramosus:* *a*, Empty glumes; *b*, the florets.

Linnaeus's good description of this species leaves little chance for doubt as to the identity of the plant. According to Dr. Gray, *Bromus kalmii* in Linnaeus's herbarium is labelled *B. ciliatus*, and this fact led to some confusion by Muhlenberg and Torrey. Our plant is very closely related to *B. ramosus*. In the Black Hills, Manitoba, and Northwest Territory it passes by various intermediate forms through *B. richardsoni pallidus* into *B. richardsoni*. It is also connected by various gradations with *B. purgans*, so that like nearly all of our species it can only be separated arbitrarily.

16*α*. **BROMUS CILIATUS LÆVIGLUMIS** Scribn. in herb. n. var.

This differs from the species chiefly in having the flowering glumes entirely smooth or with a very slight amount of pubescence on the margin at the base. The type specimen has a somewhat narrower and less drooping panicle than the species, but other plants referred to below have about the typical *B. ciliatus* panicle.

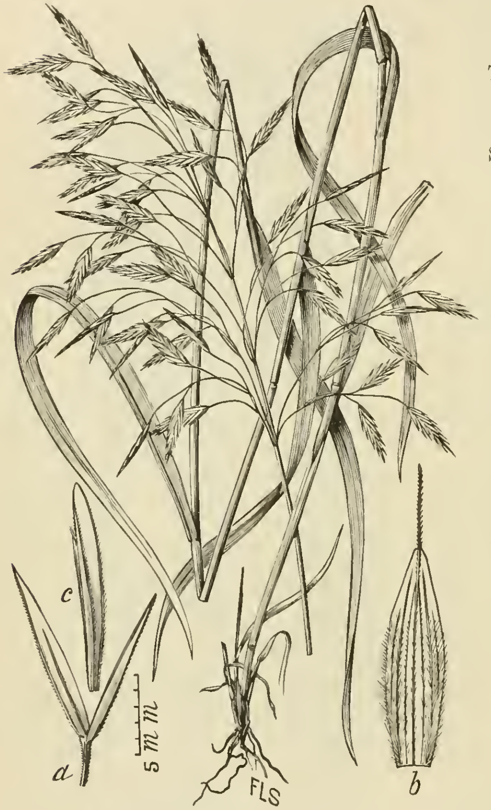

Fig. 16.—*Bromus ciliatus: a*, empty glumes; *b*, dorsal view of a flowering glume; *c*, palea.

Type collected by W. Herriott, Galt, Ontario, Canada, July, 1898.

Specimens examined.—*Maine:* Dead River (Fernald & Strong 488). *North Carolina:* Magnetic City (A. G. Weatherby 197 and 140); Swain County (Beardslee & Kofoid 9).

17. BROMUS RICHARDSONI

Link, Hort. Berol. **2**: 281. 1833. *Bromus purgans longispicata* Hook. Fl. Bor. Am. **2**: 262. 1840. *Bromus ciliatus scariosus* Scribn. U. S. Dept. Agr. Div. Agros. Bul. **13**: 46. 1898. (Fig. 17.)

An erect, robust, tufted, short-lived perennial, about 6–13 dm. high. Culm smooth. Sheaths typically smooth below and pilose at the throat, sometimes scantily pilose throughout; ligule truncate, lacerate, 1–2 mm. long; blades linear-lanceolate, 15–25 cm. long and about 5–12 mm. broad, *mostly scabrous above and glabrous beneath*. Panicle usually large, effuse, and drooping, about 15–25 cm. long. Spikelets drooping terete-acuminate at first, becoming oblong-lanceolate and laterally compressed, *mostly 2–3 cm. long*, 6–11-flowered; empty glumes smooth, the lower acuminate; 1-nerved or rarely with two faint lateral nerves, *8–10 mm. long;* the upper 3- or rarely 5-nerved, *9–12 mm. long*, obtuse, or inequilateral and mucronate; flowering glume obtuse, emarginate, 7-nerved, *12–15 mm. long. appressed ciliate-pubescent from the second nerve to the margin and nearly to the apex, also across the back at the base;* awn straight 3–5 mm. long; palea slightly shorter than its glume.

Type in the collection of the Royal Botanical Museum, Berlin, grown from seed sent by Dr. Richardson from western North America.

General distribution: Arizona and New Mexico, north in the mountains to British America.

Specimens Examined.—*Arizona:* Chiricahua Mountains (J. W. Toumey 31); Tucson (J. W. Toumey 752); San Francisco Mountains (J. G. Lemmon 3194); Rincon Mountains (G. C. Nealley 88). *New Mexico:* (Dr. G. Vasey); White Mountains (E. O. Wooton 332). *Utah:* Provo (S. M. Tracy 404); Aquarius Plateau (L. F. Ward 431); Mount Ellen (M. E. Jones 5684 bf); Alta (M. E. Jones 1132). *Colorado:* Georgetown (P. A. Rydberg 2381; C. L. Shear 610, 624½; S. M. Tracy 457); Marshall Pass (F. E. Clements 216; C. L. Shear 918); Breckenridge (C. L. Shear 1078); Sheep Horn Divide (Shear & Bessey 1541, 1539, 1548); Grand Lake (Shear & Bessey 1522); Durango (F. Tweedy 389); Ouray (C. L. Shear 1153); Buffalo Pass (Shear & Bessey 1433); Red Mountain (C. L. Shear 1204); West Mancos (Tracy, Earle & Baker 332); Dix (Tracy, Earle & Baker 4298); Upper La Plata (Tracy, Earle & Baker 987, 4303); Silver Plume (P. A. Rydberg 2466; C. L. Shear 679, 711); Buckeye canyon (G. H. French); Glenwood Springs (Shear & Bessey 1301); Robinson (C. L. Shear 1050); Red Cliff (Shear & Bessey 1281, 1284; Patterson 30); Florissant (T. A. Williams 2207); Pikes Peak (T. A. Williams 2222, 2173; Crandall & Cowen 542); Manitou (C. L. Shear 761); Cameron Pass (C. S. Crandall 116); McCoys (Shear & Bessey 1334); Villa Grove (C. L. Shear 877). *Wyoming:* Welcome (T. A. Williams 2668, 2673a); La Plata Mines (E. Nelson 5087); Sheep Mountain (T. A. Williams 2305); Cooper Hill (A. Nelson 4407); Battle Lake (A. Nelson 4022); Cement Creek, Big Horn Co. (F. Tweedy 67). *Yellowstone National Park:* Near Mammoth Hot Springs (F. H. Burgelhaus). *Montana:* Belt Mountains (F. L. Scribner 411); Hound Creek (F. L. Scribner 14).

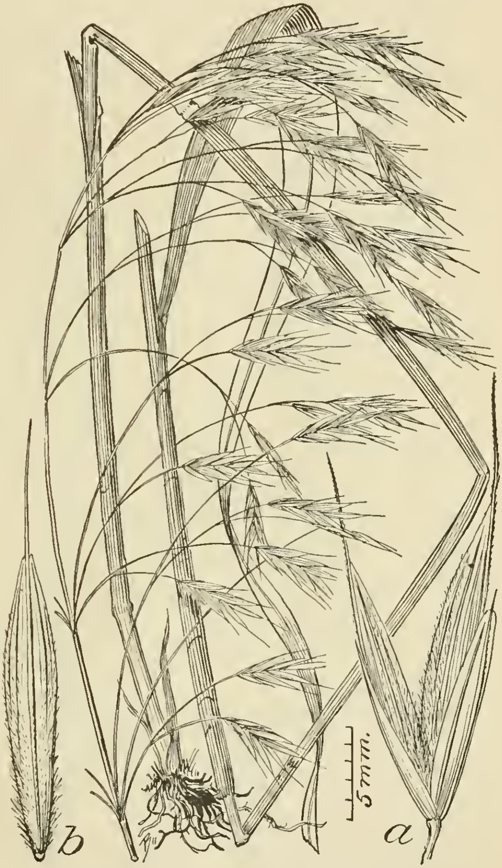

Fig. 17.—*Bromus richardsoni: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

Through the kindness of Dr. I. Urban we have been able to examine a part of the type of this species which has not heretofore been recognized by American botanists so far as we know. This species includes the great bulk of the material from the Rocky Mountains hitherto referred to *B. ciliatus*, into which it passes in British America. It is distinguished in general from *B. ciliatus* by its denser panicle, usually smooth leaves and sheaths and broader, more obtuse flowering glume, with more pubescence. Forms also occur connecting it with *B. porteri*. An examination of a spikelet from Hooker's type of *B. purgans longispicata* l. c. collected by Drummond in the Rocky Mountains shows it to be the same as *B. richardsoni*.

17*a*. **BROMUS RICHARDSONI PALLIDUS** (Hook.) n. comb. *Bromus purgans pallidus* Hook. Fl. Bor. Am. **2** : 252. 1840.

This in its typical form is distinguished from the species by the *silky-villous margin of the flowering glume*, pale green, narrower spikelets, and smaller, denser panicle. The leaves are also usually less numerous and narrower.

Type in the herbarium of the Royal Gardens, Kew, England, collected by Drummond in the Rocky Mountains.

General distribution: Western Nebraska, Colorado, and Nevada north to the Arctic coast.

Specimens Examined.—*Nebraska:* near Mullen (P. A. Rydberg 1404). *Colorado:* Grand Lake (Shear & Bessey 1525); Villa Grove (C. L. Shear 879); Gunnison (S. M. Tracy 442). *Nevada:* E. Humboldt Mount (Watson 1328). *Oregon:* Fort Klamath (J. B. Leiberg 670); Wallowa (C. L. Shear 1819); (W. C. Cusick 1289); Powder River Mountains (C. V. Piper 2528). *Washington:* Loomiston (A. D. E. Elmer 559). *Idaho:* Beaver Canyon (P. A. Rydberg 2329). *Montana:* East Gallatin Swamp (P. A. Rydberg 3170); Manhattan (C. L. Shear 431); Madison River (P. A. Rydberg 2275); Spanish Basin (P. A. Rydberg 3114); Sheep Creek (P. A. Rydberg 3304); Columbia Falls (R. S. Williams 605). *Yellowstone National Park:* Slough Creek (F. Tweedy 589). *Wyoming:* Ten Sleep (T. A. Williams 2832). *South Dakota:* Sylvan Lake (David Griffiths 721); Rochford (P. A. Rydberg 1166). *Saskatchewan:* (J. Macoun 79); Prairie Albert (J. Macoun 13045). *Alberta:* near Banff (J. Macoun 26). *British Columbia:* Elk River (R. Kennicott). *Northwest Territories:* Fort Resolution (R. Kennicott).

The examination of a spikelet from the type specimen of this variety shows that it is intermediate between *B. richardsoni* and *B. ciliatus* and intergrades with both. Its denser panicle, fewer, narrower, and smoother leaves with the longer, silky pubescence of the flowering glume separate it in its typical form from the latter species. It sometimes resembles *B. porteri* in everything but the distribution and character of the pubescence of the flowering glume.

18. **BROMUS KALMII** A. Gray, Man. Bot. 600. 1848. *Bromus ciliatus* Muhl. Gram. 169. 1817. Not L. 1753. *Bromus purgans* Torr. Fl. N. Y. **2** : 468. 1843. Not L. 1753. (Fig. 18.)

An erect, rather slender perennial with a drooping panicle. Culm 5–9 dm. high, *usually pubescent just below the nodes.* Culms leaves about 3: sheaths usually shorter than the internodes, *moderately retrorsely pilose-pubescent, at least the lower ones;* ligule about .5 mm. long, truncate, laciniate; blades flat, broadly linear-lanceolate, 7–17 cm. long, 5–10 mm. broad, *usually sparsely pilose-pubescent both sides*, rarely nearly smooth or scabrous. Panicle small, rather crowded, 5–15 cm. long, average about 10 cm.; lower branches 2–3, very slender and somewhat flexuous, bearing 1–2 spikelets. Spikelets drooping, oblong-ovoid, closely 7–13-flowered, 1.5–2.5 cm. long, 5–6 mm. broad; empty glumes *coarsely pubescent, the lower linear-lanceolate, 3-nerved*, 5–6 mm. long, the upper broader, obtuse, *7–8 mm. long, 5-nerved*, the outer nerves sometimes indistinct; flowering glumes obtuse, emarginate, densely and coarsely silky-pubescent, 7-nerved, 8–10 mm. long; awn straight, 2–3 mm. long; palea a little shorter than the glume; joints of the rachilla pubescent, 1–1.5 mm. long.

Type: There seems to be no particular specimen designated as the type of this species by Dr. Gray. The sheet in the Gray herbarium, regarded as that upon which the original description was founded, contains portions of plants from three different localities, two from New York and one from Michigan, varying however but very little from each other. These were taken as the basis of the above description.

General distribution: New England to Minnesota.

Specimens Examined.—*New York:* Sodus Bay (O. E. Pearce in 1884); Ithaca (K. M. Wiegand in 1895; F. V. Coville in 1885). *Pennsylvania:* Easton (A. P. Garber in 1867 and 1868; T. C. Porter, in 1868, 1891, and 1897). *Wisconsin:* Valley of Wisconsin River (L. D. Cheney 2031); (Dr. G. Vasey in 1883); Madison (T. J. Hale in 18—). *Minnesota:* St. Cloud (E. V. Campbell 55 and 56); Turtle Lake (E. P. Sheldon in 1892).; Zumbrota (E. A. Mearns 775); Lake Minnewaska (L. R. Moyer 1b).

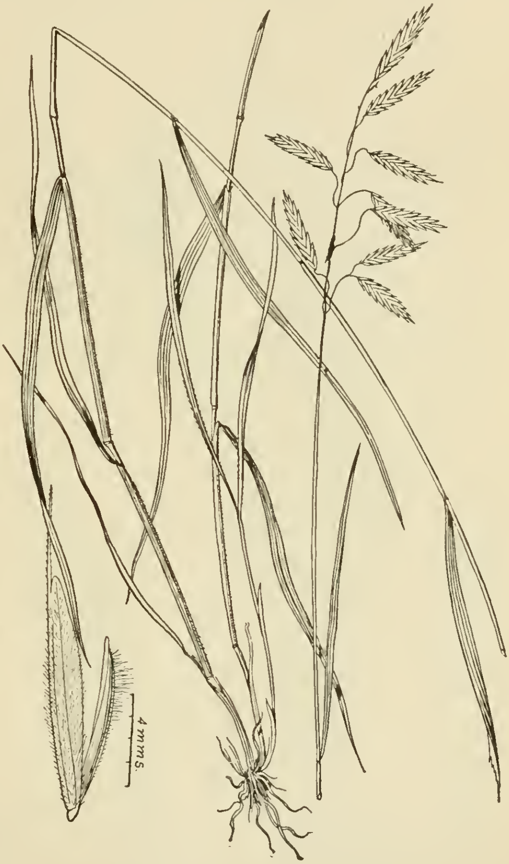

Fig. 18.—*Bromus kalmii.*

19. BROMUS PORTERI (Coult.) Nash; *Bromus kalmii porteri* Coult. Man. Bot. Ry. Mt. Reg. 425. 1885; *Bromus porteri* Nash. Bul. Torr. Bot. Club, **22**: 512. 1895; *Bromus kalmii occidentalis* Vas. in Beal Grass. N. A. **2**: 625. 1896; *Bromus ciliatus montanus* Vas. in Beal Grass. N. A. **2**: 619. 1896. not *Bromus montanus* Retz. 1779; *Bromus kalmii* of most auct. amer.; *Bromus kalmii major* Vas. in herb. (Fig. 19.)

A tufted short-lived perennial with rather slender, erect culms about 5–9 dm. high, slightly puberulent toward the top and pubescent at the nodes, bearing from 3–4 leaves. Sheath scantily short pilose or smooth, usually shorter than the internodes; ligule 1 mm. or less long, truncate, dentate; blades of the culm about 7–14 cm. long by 3–5 mm. wide, linear-lanceolate, somewhat erect, *rather distant and usually scabrous,* those of the innovations longer and narrower. Panicle 8–20 cm. long, averaging about 12 cm., drooping, lower branches mostly 2–4, subcapillary. Spikelets terete-lanceolate before flowering, 2–2.5 cm. long, usually 7–9 flowered; empty glumes mostly obtuse, short-pubescent or sometimes nearly smooth, lower 5–7 mm. long, narrower, sometimes subacute, *usually 3-nerved but* *lateral nerves rather short, inconspicuous and sometimes wanting;* the upper 7–9 mm. long, distinctly 3-nerved, obtuse; flowering glume 11–13 mm. long, broad-lanceolate, rather coarsely pubescent, apex hyaline, entire, or slightly emarginate; awn 2–4 mm. long, inserted just below the apex; palea mostly slightly shorter than its glume.

Type: The following specimens are cited with the original description l. c. "Colorado, at Twin Lakes (Porter), Buffalo Peaks, and Sierra Madre Range (Coulter)."

Specimens from both the collections referred to have been seen and the above description based on them.

General distribution: Arizona and New Mexico north to Manitoba and west to Alberta. Found in its most characteristic form in the Rocky Mountains at an altitude of 2–3000 meters.

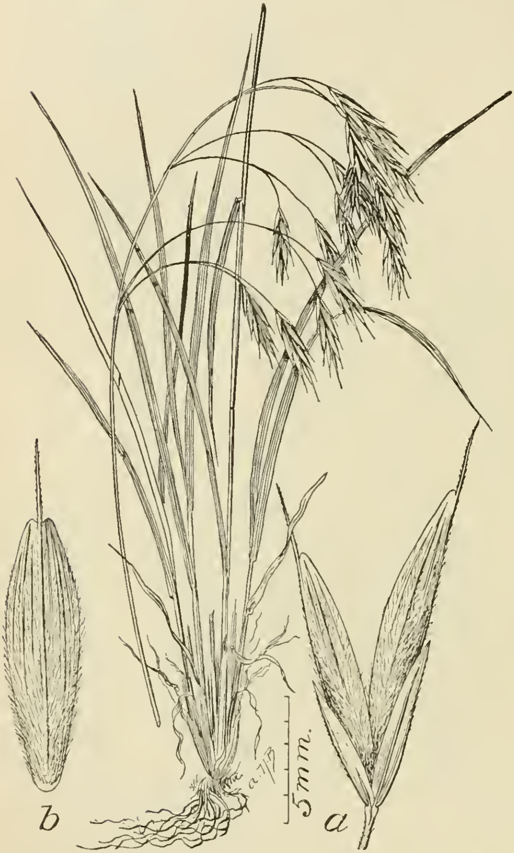

Fig. 19.—*Bromus porteri: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

Specimens examined. — *Arizona:* Huachuca Mountains (F. X. Holzner 2164); a large form not typical; Tucson (J. W. Toumey). *New Mexico:* Glorietta (G. R. Vasey). *Colorado:* Steamboat Springs (Alice Eastwood 20); Mancos (Tracy, Earle & Baker 104, 382, 432); Silverton (C. L. Shear 1216); West Mancos Canyon (Tracy, Earle & Baker 332); Fort Collins Gulch (L. H. Pammel); North Park (C. F. Baker 24, 49; C. S. Sheldon 177); Sheep Horn Divide (Shear & Bessey 1540); Red Dirt Divide, Routt County (Shear & Bessey 1350, 1355); Marshall Pass (S. M. Tracy 459; C. L. Shear 934); Garland (C. L. Shear 854; G. Vasey); Crested Butte (Alice Eastwood 10a); Robinson (C. L. Shear 1054); Durango (Tracy, Earle & Baker 986, 4302); West Cliff (C. L. Shear 993); Twin Lakes (John Wolfe 1155–6); Gunnison (S. M. Tracy 442), Harmons Lake (Tracy, Earle & Baker 4300). *Utah:* Fish Lake (M. E. Jones 5743); Bromide Pass (M. E. Jones 5699bb); Above Kings Meadows (L. F. Ward 313); Cashe Junction (C. L. Shear 597); Aquarius Plateau (L. F. Ward 431). *Wyoming:* Sundance (Griffiths 420, 423, 436, 946; T. A. Williams 2604); Little Missouri Buttes (D. Griffiths 584); Bear Lodge Mountains (T. A. Williams 2642); Wind River (W. H. Forwood); Evanston (G. W. Letterman 3; T. A. Williams 2395, 2424); Elk Mountain (A. Nelson 4083); Gros Ventre (F. Tweedy 66); Woods Landing (A. Nelson 3922, 3848); Meeteetse Creek (T. A. Williams 2879); Spread Creek (F.

Tweedy 63); Tongue River Basin (B. C. Buffum 5116); Hulett (D. G. Griffiths 924); Big Horn Mountains (W. H. Forwood); Little Laramie River (T. A. Williams 2239); Seminole Mountains (E. Nelson 4931); Sand Creek (A. Nelson 1105); Inyan Kara Creek (T. A. Williams 2581); Crazy Womans Creek (T. A. Williams 2734). *Idaho:* Beaver Canyon (P. A. Rydberg 2344); Snake River (G. W. Letterman 90). *Yellowstone National Park:* Yellowstone Lake (A. Nelson 6628); Cash Creek (F. Tweedy 588). *Montana:* Spanish Creek Basin (T. A. Williams 2050); Northern Pacific R. R. (F. Lamson-Scribner); Lima (C. L. Shear 566; P. A. Rydberg 2315); Barker (P. A. Rydberg 3361); Castle (P. A. Rydberg 3253); Spanish Creek (P. A. Rydberg 3047). *South Dakota:* Rochford (P. A. Rydberg 1165). *North Dakota:* Bottineau (M. A. Brannon 79, 87, 92); Devils Lake (C. A. Geyer). *Manitoba:* Brandon (J. Macoun 13049); Rapid City (J. Macoun 13047). *Assiniboia:* Moose Jaw (J. Macoun 13043). *Saskatchewan:* (J. Macoun 77). *Alberta:* Milk Rim Ridge (J. Macoun 13037).

This is the western expression of *B. kalmii*, and but for its geographical distribution, I should be inclined to regard it as a variety of that species into which it passes by way of Minnesota and Canada. It is usually distinguished from that species by its smooth, narrower leaves, and narrower, fewer-nerved, empty glumes. It is also connected by intermediate forms with *B. richardsoni.*

19 *α*. **BROMUS PORTERI LANATIPES** n. var.

In its typical form this is a robust plant whose most striking character is its densely soft-downy or woolly sheaths. The leaves are scabrous both sides and larger than in the species; the panicle mostly larger and denser with spikelets somewhat larger and the empty glumes merely scabrous on the nerves or quite smooth.

Type No. 739, collected by C. L. Shear, Idaho Springs, Colo.

General distribution: Southern California, Arizona, New Mexico, and Colorado.

Specimens examined.—*California*: San Bernardino Mountains (S. P. Parish 253 & 2533a; S. B. & W. F. Parish 1535). These specimens not typical. *Arizona*: Dos Cabezas (J. D. Emersley); no locality (J. D. Emersley 8). *Colorado*: Boulder (G. W. Letterman 9); Idaho Springs (C. L. Shear 739; P. A. Rydberg 2490 & 2496); La Veta (C. L. Shear 811); Golden (G. W. Letterman 8); M. E. Jones 269); Trinidad (S. M. Tracy 12½); Walsenburg (C. L. Shear 799).

This variety passes by various forms into the species. It also closely approaches *B. richardsoni.* The specimens cited from southern California have the sheaths less densely pubescent and approach *B. lævipes.*

19 *β*. **BROMUS PORTERI HAVARDII** nom. nov. *Bromus ciliatus minor* Munro, Dewey in Contr. U. S. Nat. Herb. **2:** 548. 1894. Not *B. macranthus minor* Desv. 1853.

An erect, rather densely tufted plant, *glaucous and nearly smooth throughout.* Spikelets 15–18 mm. long; empty glumes unequal, *the lower 1-nerved 3–5 mm. long,* the upper 3-nerved, *5–6 mm. long,* flowering glume 7–8 mm. long. Awn about 2 mm. long. This differs from the species in its glaucous more rigid leaves and smaller, somewhat more coarsely pubescent spikelets.

Type No. 20, collected by V. Havard, slopes of Chisas Mountain, Vieja Mountain, west Texas.

19 *γ*. **BROMUS PORTERI FRONDOSUS** n. var. (Fig. 20.)

A slender, weak, erect or ascending, somewhat tufted perennial, about 6–9 dm. high. Culm smooth, leafy. Sheaths smooth; ligule about 1 mm. long, truncate and irregularly dentate; *blades linear, weak,* mostly 1–2 dm. long and 3–4 mm. wide, *smooth throughout.* Panicle 1–2 dm. long, *very weak and drooping;* lower branches 2–4. Spikelets 2–2.5 cm. long, 7–11-flowered, oblong-lanceolate in flower, pale green and drooping; empty glumes *3-nerved, smooth,* mostly acute, lower 5–6 mm. long, upper 6–7 mm. long, slightly broader; flowering glume subacute, *9–11 mm. long, softly pubescent over the back*, 5–7-nerved, only 3 nerves very distinct, hyaline at the apex and emarginate, awn 2–3 mm. long; palea puberulent, nearly equaling its glume.

Type collected by J. G. Smith at Mangos, New Mexico, August 19, 1897.

Specimens examined.—*New Mexico:* Mangos Canyon (J. G. Smith, Sept. 21, 1896); (O. Metcalfe, Sept. 20, 1897); Saddle Rock Canyon, Grant County, alt. 2,170 meters (J. G. Smith, Sept. 24, 1896).

Base of San Luis Mountains, International Boundary Collection (E. A. Mearns 2146).

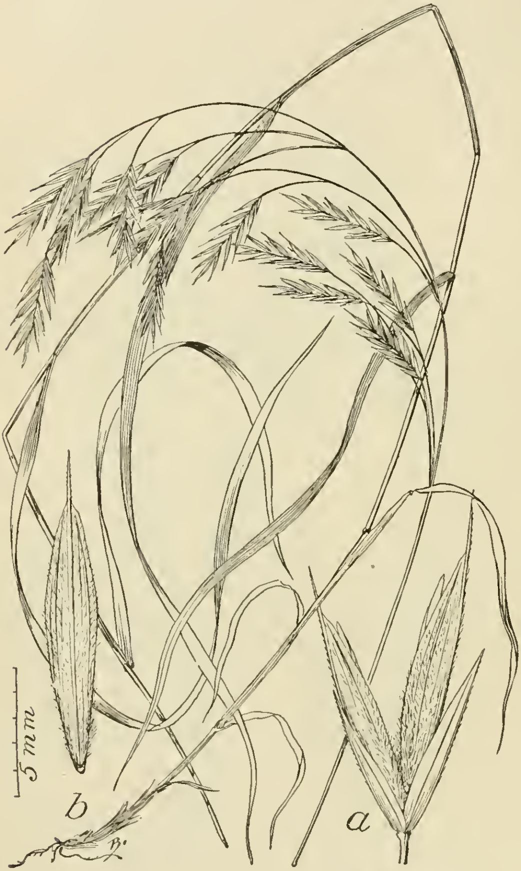

Fig. 20.—*Bromus porteri frondosus: a*, empty glumes and two florets; *b*, dorsal view of a flowering glume.

This plant, whose favorite habitat seems to be among cliffs in canyons, may prove on further field study to be found worthy of specific rank. The herbarium specimens differ from the species in their very weak, leafy culms, rather narrower and less densely flowered spikelets with the empty glumes smooth.

20. BROMUS PACIFICUS

n. sp. (Fig. 21.)

A stout, nearly erect perennial 10–15 dm. high. Culm leafy, pubescent at the nodes. Sheaths mostly sparsely retrorsely-pilose; *ligule 3–4 mm. long*, rounded above, somewhat lacerate dentate; *blades broadly linear-lanceolate, 2–3.5 dm. long, 8–11 mm. broad, sparsely coarse-pilose above, scabrous beneath. Panicle rather large, dense, drooping;* lower branches secund, 3–5. *Spikelets 2–2.5 cm. long, 5–6 mm. wide*, 7–11-flowered, *coarsely pubescent throughout;* empty glumes acute, the lower rather narrow, 1-nerved or rarely with two short faint lateral nerves, 6–7 mm. long, the upper broader, *3–5-nerved, mostly inequilateral at the apex and mucronate, 8–9 mm. long;* flowering glume inconspicuously 7-nerved, broadly lanceolate, subobtuse, emarginate, 11–12 mm. long, *pubescence somewhat denser and somewhat pilose on the lower margins and base, with a straight awn 4–6 mm. long;* palea about equaling its glume.

Type No. 1703, collected by Scribner & Shear, in moist thickets near the seashore south of Seaside, Oregon.

General distribution: Along the coast from Oregon to Alaska.

Specimens examined.—*Oregon:* Seaside (Scribner & Shear 1711). *Vancouver Island:* (J. Macoun 93). *Alaska:* Prince of Wales Island (W. G. Wright 1595).

This species appears nearly related to *B. richardsoni*, but is much more robust, with rather denser panicle and coarser pubescence which covers the empty glumes as well as the flowering glumes. It appears to be the same as the *B. purgans* of Grisebach in Ledebour's "Flora Rossica."

21. **BROMUS PURGANS** L. Sp. Pl. **1**:76. 1753. *Bromus ciliatus purgans* A. Gray, Man. Bot. 600. 1848. (Fig. 22.)

Bromus steudelii Frank in Steud. Nom. Bot. ed. 2. **1**:229. 1840. nom. nud.

A rather stout perennial, 7–14 dm. high. Culm erect, smooth or pubescent at the nodes. Sheaths usually coarsely retrorse-pilose; ligule 1–2 mm. long, rather firm, truncate; blades broadly linear-lanceolate, 15–30 cm. long, 5–15 mm. broad, somewhat auricled at the base, short-pilose on the nerves above or smooth, scabrous or smooth beneath. Panicle large, lax, nodding, mostly 15–25 cm. long; lower branches 2–4, long, slender, flexuous. Spikelets mostly 7–11 flowered (Linnæus says "8 ad 14"), 2–2.5 cm. long, terete-acuminate at first, becoming oblong-lanceolate in outline and somewhat flattened; empty glumes narrow, acuminate, *sparsely covered with short pubescence;* the lower *1-nerved, 5–7 mm. long;* the upper broader, 3-nerved, *7–9 mm. long;* flowering glume lanceolate, acute, or sub-acute; 5-nerved, or sometimes with two more faint nerves when mature, *10–12 mm. long, with rather short sparse pubescence over the back,* emarginate or shortly bidentate at the apex; awn straight, slender, *4–6 mm. long;* palea nearly equaling its glume, rachilla slender, pubescent, 2–3 mm. long.

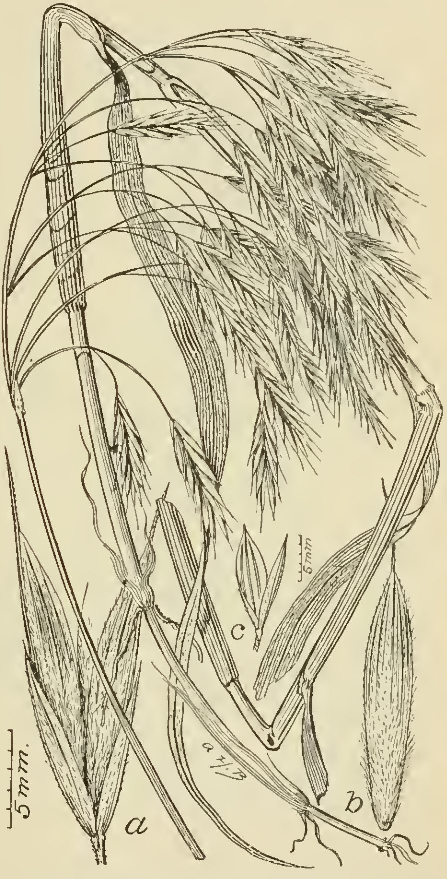

Fig. 21.—*Bromus pacificus: a,* empty glumes with two florets; *b,* dorsal view of the flowering glume.

Type collected by Kalm in Canada.

General distribution; New England to Florida, west to northeastern Wyoming, and south to Texas.

Specimens examined.—*Connecticut:* Bridgeport (E. H. Eames). *New York:* Ithaca (F. V. Coville); Little Falls (G. R. Vasey). *New Jersey:* Stockholm (Wm. M. Vansickle). *Pennsylvania:* Huntingdon County (T. C. Porter); Easton (T. C. Porter); Philadelphia (C. E. Smith 39; F. Lamson-Scribner). *Delaware:* Wilmington (A. Commons 79, 130). *Maryland:* Baltimore (K. A. Taylor 11802). *District of Columbia:* Washington (F. Blanchard); Chain Bridge (Conant & Vasey).

North Carolina: Biltmore (Biltmore Herbarium 128a). *Georgia:* Rome (Dr. Chapman). *Tennessee:* Knoxville (A. Ruth 30); Franklin County (H. Eggert 28). *Kentucky:* Big Black Mountain (T. H. Kearney jr. 276). *Ohio:* Cincinnati (C. G. Lloyd 3515). *Illinois:* Chicago (H. N. Babcock); Mount Carmel (J. Schrenck). *Michigan:* Rochester (O. A. Farwell 563). *Iowa:* Lebanon (C. R. Ball and A. F. Sample 26); Ames (C. R. Ball 123); Fayette County (B. Fink 290, 629); Decatur County (T. J. and M. F. L. Fitzpatrick 12). *Minnesota:* Duluth (G. Vasey). *Wyoming:* Sundance (T. A. Williams 2596). *Nebraska:* Julian (C. L. Elmore 135); near Mullen (P. A. Rydberg 1775). *Missouri:* Independence (B. F. Bush 812); Courtney (B. F. Bush 594). St. Louis (H. Eggert). *Arkansas:* (F. L. Harvey 9). *Indian Territory:* Between Fort Cobb and Fort Arbuckle (Dr. E. Palmer 407).

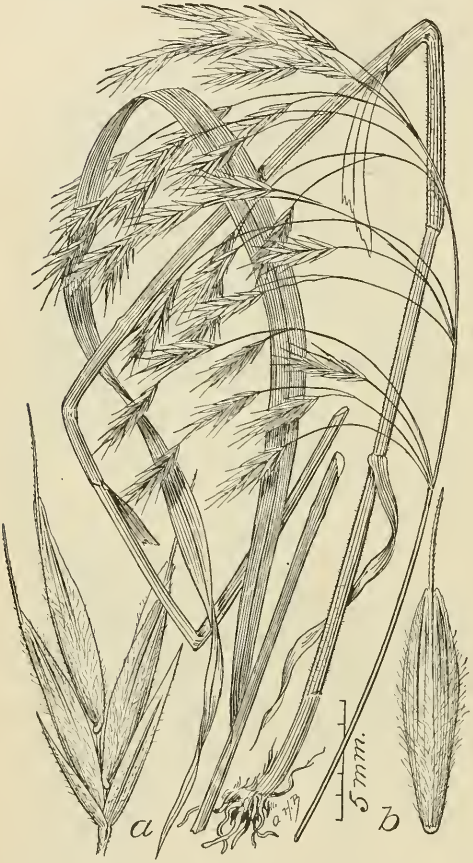

FIG. 22.—*Bromus purgans:* *a*, lower portion of a spikelet; *b*, dorsal view of a flowering glume.

This species has been the cause of much confusion, and has been very differently interpreted by different authors. Some, including Vahl, Hooker fil., Grisebach, and Fournier, apparently accepting Linnæus's doubtful reference to Feuillée's plate of *B. catharticus* as the true *B. purgans*, have referred various forms of the subgenus *Ceratochloa* to it. Others, as Torrey and Hooker, have referred *B. kalmii* and related forms to it, while Dr. Gray seems to have been the first to apply the name to the plant described by Linnæus, whose description is so complete as to leave little doubt as to the plant he had in hand. The species shows occasional connecting forms with *B. ciliatus.* It is also very closely related to *B. ramosus* of Europe. In the West and North it appears to merge into *B. richardsoni.* It is distinguished from *B. kalmii*, another near relative, by its longer and narrower empty glumes and the shorter and sparser pubescence of the flowering glumes, as well as by its larger panicle and broader leaves.

A specimen in the Columbian University herbarium from Meisner's Herbarium, collected by Frank near Cincinnati, and labeled "*Bromus steudelii* Frank n. sp.?" is merely a form of this species with a somewhat smaller panicle than usual.

21*a*. **BROMUS PURGANS LATIGLUMIS** (Scribn.) n. comb. *Bromus ciliatus latiglumis* Scribn. in herb. *Bromus altissimus* Pursh, Fl. Am. Sept. 2 : 728. 1814. Not Gilib. 1792. *Bromus ciliatus porteri* Rydb. Contr. Nat. Herb. 3 : 193. 1895.

Culms very leafy, sheaths usually much overlapping and *furnished with a rather conspicuous pilose-pubescent ring at the summit;* blades rather broadly auricled at the base. Spikelets and flowering glumes *rather broader than in the species.* The pubescence at the base of the flowering glume is slightly denser than elsewhere. In other respects like the species.

Type No. 222, collected by L. H. Pammel, Dakota City, Iowa.

General distribution about the same as for the species, but apparently reaching its greatest development in numbers west of the Mississippi.

Specimens examined.—*Connecticut:* South Glastonbury (Frances Wilson 124). *New York:* Oxford (F. V. Coville). *Pennsylvania:* Easton (T. C. Porter). *Minnesota:* Forest Mills (C. A. Ballard). *South Dakota:* Redfield (David Griffiths 74); Big Stone (Mr. & Mrs. T. A. Williams; James River, Brown County (David Griffiths 784); Canning (T. A. Williams). *Montana:* Smith River (F. Lamson-Scribner 77). *Nebraska:* near Thedford (P. A. Rydberg 1775—this number is the one on which Rydberg founded the new combination cited above. In character of spikelets and in the rather narrower leaves than usual it approaches *B. porteri*, but in other respects it is this variety; Holt County (F. Clements 2824). *Iowa:* Forest City (B. Shimek 62); Ames (C. R. Ball 4); Jackson County (B. Shimek 34); Dakota City (L. H. Pammel 222). *Missouri:* (H. Eggert); Jefferson County (H. Eggert 606); Allenton (G. W. Letterman 14).

This form connects the species with *B. richardsoni* and *B. porteri*, the more numerous leaves, the overlapping sheaths, and larger panicle separating it from the latter. The overlapping sheaths and more equally distributed pubescence of the flowering glume distinguishes it from the former. The citation of *B. altissimus* Pursh as a synonym is based upon the examination of specimens in the herbarium of the Philadelphia Academy marked "Herb. Pursh." The specimens agree perfectly with Pursh's description and are apparently authentic.

21β. BROMUS PURGANS ? TEXENSIS n. var.

A slender plant, somewhat geniculate at the base and 3–4 dm. high. Sheaths short pilose-pubescent; ligule 1–1.5 mm. long, laciniate; blades linear, *pubescent throughout*, about 6–10 cm. long. Panicle small, somewhat nodding, with only 3–5 spikelets in the specimen at hand. Spikelets terete at first, then lanceolate and somewhat laterally contracted; empty glumes acuminate, scabrous, the lower 1-nerved, 7 mm. long, the upper inequilateral and mucronate at the apex, 9–10 mm. long; flowering glume 7-nerved, 10 mm. long, *sparsely and coarsely scabrous*, very short dentate at the apex; awn straight, 6–7 mm. long; palea equaling its glume, *keels finely serrate.*

Type No. 230, collected by G. Jermy, Bexar County, Texas.

This is the only specimen of this form we have seen. More material is necessary to determine definitely its status and relationships. It may prove a good species.

21γ. BROMUS PURGANS INCANUS n. var.

This is very near *B. purgans latiglumis*, differing from it in having the sheaths densely soft pilose-pubescent. It also passes into *B. porteri lanatipes* in the southwest. It is generally separated from that by its broader leaves and narrower empty glumes, which are like the flowering glumes sparsely pubescent.

Type No. 3, collected by J. Wolf, Canton, Illinois.

General distribution apparently about the same as for the species.

Specimens examined.—*Pennsylvania:* Easton (T. C. Porter). *District of Columbia:* High Island (F. L. Scribner). *Ohio:* Pittsfield (A. E. Ricksecker). *Iowa:* Fayette County (B. Fink, 414). *South Dakota:* Union County (E. J. Wallace). *Texas:* Chenates (G. C. Nealley), poor and not typical.

22. BROMUS ORCUTTIANUS Vas. Bot. Gaz. **10**: 223. 1885. (Fig. 23.)

A rather stout, erect, perennial 8–12 dm. high. Culm leafy below, mostly puberulent at and just below the nodes. Sheaths *usually glabrous;* ligule 1–2 mm. long, subtruncate; blades *broadly linear-lanceolate, rather coarse, smooth throughout,* 10–20 cm. long, 5–7 mm. broad. *Panicle narrow-pyramidal, erect, or nearly so,* 10–15 cm. long, 5–8 cm. broad at the base when spread, branches few, *widely divaricate in fruit and rather rigid.* Spikelets about 2–2.5 cm. long, 2–3 mm. broad, on short, stout pedicles, terete-acuminate, 5–9 flowered; florets at maturity rather distant on a slender zigzag rachilla, separating and falling easily at maturity; empty glumes narrow, smooth or scabrous, the lower acute, 6–8 mm. long, 1-nerved, or sometimes with 2 short, faint lateral nerves, the upper broader, subobtuse, 3-nerved, 8–10 mm. long; flowering glume 10–12 mm. long, narrow, obtuse, *scabrous to scabrous-pubescent over the back,* faintly 5–7-nerved, with a hyaline, slightly emarginate apex; awn rather stout, about 5–7 mm. long; palea nearly equaling its glume; rachilla slender, puberulent, joints about 4 mm. long.

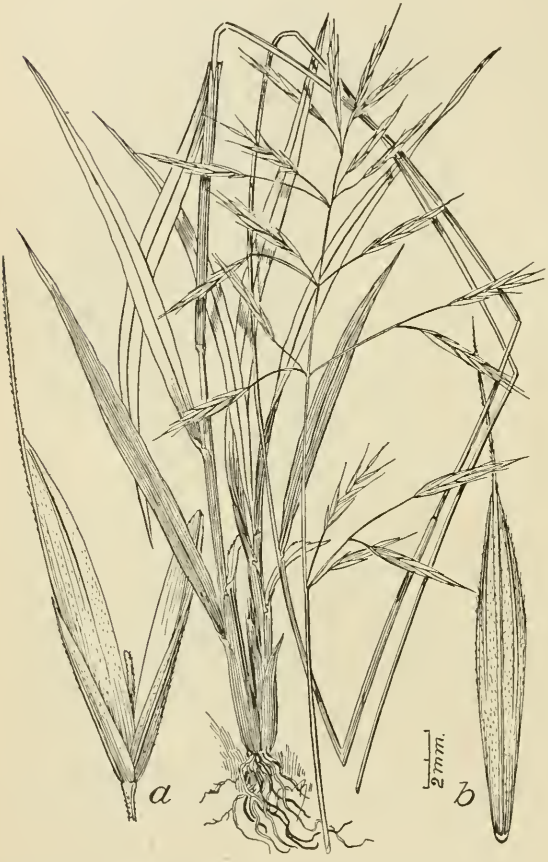

Fig. 23.—*Bromus orcuttianus:* a, empty glumes with a floret; b, dorsal view of a flowering glume.

Type in the Herbarium U. S. Department of Agriculture, collected by C. R. Orcutt in the mountains near San Diego, Cal., No. E.

General distribution: Southern California to Washington, chiefly on rather dry open mountain sides and in dry evergreen forests.

Specimens examined.—*California:* Open woods, Truckee River (C. F. Sonne 21); Southern California (Dr. E. Palmer 233); Mariposa (J. W. Congdon); Pioneer (Geo. Hansen 1835); Kaweah River Valley (Coville and Funston 1346); San Jacinto Mountains (H. M. Hall 7861); Forest Dale (J. B. Davy). *Oregon:* Ashland Butte (T. Howell 253); Gayhart Butte (Coville and Leiberg 277). *Washington:* Mount Adams (W. N. Suksdorf 120); Klickitat River near Mount Paddo (Mount Adams) (W. N. Suksdorf 172).

22*a*. BROMUS ORCUTTIANUS GRANDIS n. var.

A stout, erect perennial 14–15 dm. high, very leafy below. Sheaths, leaves, and culm pubescent throughout. Panicle about 2 dm. long and nearly as broad at base at maturity when the branches are spread more or less horizontally. Spikelets pubescent throughout. Its distinguishing characters are its size and pubescence. In other respects the plant is like the species.

Type No. 472, collected by C. R. Orcutt at La Maite, San Diego, California. The only specimen seen.

23. BROMUS VULGARIS (Hook) n. comb. (Fig. 24.)

B. purgans vulgaris Hook. Fl. Bor. Am. **2** : 252. 1840. *B. debilis* Nutt. in Herb. Acad. Nat. Sci. Phil. *B. ciliatus pauciflorus* Vasey in Beal Grass. N. A. **2** : 619. 1896. Not Schum. nor Willd. *B. ciliatus ligulatus* Vas. in Macoun Cat. Can. Pl. **4** : 238. 1888. Nomen nudum.

A slender, erect perennial 8 to 11 dm. high, with narrow, pale green, *sparingly pilose leaves and few-flowered, nodding panicle*, 8 to 12 cm. long. Culms somewhat pubescent, at least below the nodes, nodes bearded, the short hairs directed downward. Sheaths *pilose, lower ones which are usually purplish, quite densely so, with spreading or reflexed hairs;* ligule *membranous or subhyaline, truncate, lacerate, 3–5 mm. long;* blades 15–25 cm. long, 5–9 mm. wide, thinly pilose above, glabrous or sparsely pilose beneath, sparingly scabrous on the margins and on the nerves below. Spikelets about 22–28 mm. long, including awns, 3–4 mm. wide; pedicels somewhat enlarged just below the spikelet and pubescent; empty glumes *somewhat sparsely covered with a short, coarse pubescence*, lower glume narrow-lanceolate, very acute, 5–8 mm. long, 1-nerved; upper glume *3-nerved, much broader and longer than the first, obtuse or subacute and often bifid at the apex, the midnerve excurrent as a short awn*, seabrous on the back, the nerves usually purplish; flowering glume about 8–10 mm. long, *sparsely pubescent over the back, subciliate near the margins*, 5-nerved, the 3 nerves much more prominent than the intermediate

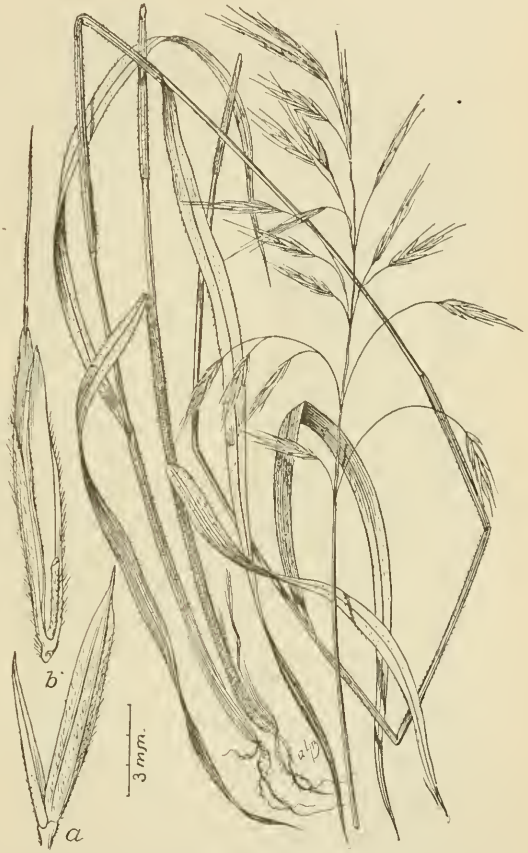

FIG. 24.—*Bromus vulgaris: a*, showing empty glumes : *b*, partial ventral view of a floret showing the palet and a joint of the rachilla.

ones; apex entire or shortly 2-toothed; awns *slender, 6–9 mm. long*. Joints of the rachilla 2–3 mm. long, pubescent; palea nearly or quite equaling its glume, ciliate on the keels and scantily pubescent between them.

Type: Hooker l. c. refers several collections made by Richardson, Douglas, and Scouler to this species. Through the kindness of the director of the Kew Gardens we have received a spikelet from the specimens collected by Dr. Scouler on the Columbia which proves to be the same as the synonyms given.

General distribution: California north to Vancouver Island, east to Montana and the Blue Mountains of Oregon. The typical form seems to be most frequent in the Blue Mountains.

SPECIMENS EXAMINED.—*California:* Santa Cruz (M. E. Jones); Marin Co. (E. Palmer 2043); (C. L. Anderson 66;) (H. Bolander 4753.) *Oregon:* (W. C. Cusick 1061, 2061;) (T. Howell 80, 205;) banks Santiam (M. Craig); Portland (T. Howell); McMinnville (C. L. Shear 1652); Lake Wallowa (C. L. Shear 1747); Blue Mountains (C. L. Shear 1690, 1667). *Washington:* Klickitat River (W. N. Suksdorf 177); West Klickitat Co. (W. N. Suksdorf 175); Upper Valley Nesqually (O. D. Allen 41); Blue Mountains (C. V. Piper 2564, 2563; Lake & Hull 2079); (Sandberg & Leiberg 449;) (L. F. Henderson 2145;) Tacoma (A. B. Leckenby). *Idaho:* Latah Co. (C. V. Piper 1740); Moscow Mountains (L. F. Henderson); Lake Coeur d'Alene (Sandberg, Heller & McDougal 582); Farmington (Sandberg, Heller & McDougal 523); Nez Perces Co. (A. A. & E. G. Heller 3423). *Montana:* Bozeman (P. A. Rydberg 2227); Sour Dough Canyon (J. W. Blankinship). *British Columbia:* Deer Park, Lower Arrow Lake (J. Macoun 17).

This plant has most frequently been referred to *B. ciliatus* heretofore, but is easily separated from that species by its smaller panicle, longer awn, and long ligule, and also by the distribution of the pubescence on the flowering glume. It is quite variable in some respects and seems to pass through its various forms into *B. læripes*.

23*α*. **BROMUS VULGARIS EXIMIUS** n. var. *Bromus ciliatus glaberrimus* Suksdorf in herb. Not *B. glaberrimus* Koch, Linnæa, **21**: 420. 1848.

A more erect and robust plant than the type, leaves broader, in the type 1 cm. broad, leaves, sheaths, and culms glabrous as is also the flowering glume except on the margin and midnerve near the base where it is scantily pubescent.

Type No. 1791, collected by C. L. Shear on moist, open mountain side 4 miles above Wallowa Lake, Oregon.

General distribution: Oregon and Washington.

SPECIMENS EXAMINED.—*Oregon:* near Wallowa Lake (C. L. Shear 1787, 1799). *Washington:* Skamania Co. (W. N. Suksdorf 2335). This number was the type of Suksdorf's variety cited above. Yakima region (F. Tweedy, July, 1882).

23*β*. **BROMUS VULGARIS ROBUSTUS** n. var.

A tall leafy form sometimes reaching 15–18 dm. high; leaves and sheaths sparsely pilose-pubescent; the panicle larger than in the species and having the flowering glumes pubescent on the margin and keel at the base, as in *B. vulgaris eximius*, from which it differs chiefly in the pilose-pubescent leaves and sheaths and rather larger panicle.

Type No. 1710, collected by Scribner and Shear in moist thickets near the seashore, Seaside, Oregon.

General distribution: Oregon to Vancouver Island along the coast; also from Idaho.

Specimens examined.—*Oregon:* Seaside (Scribner & Shear 1707, 1710); McMinnville (C. L. Shear 1653). *Idaho:* Weisners Peak (Sandberg, Heller & McDougal 599). *Washington:* Base of Mount Adams (W. N. Suksdorf 176); near Montesano (A. A. & E. G. Heller 3999). *Vancouver Island:* (J. Macoun 176) not typical.

24. BROMUS LÆVIPES n. sp. (Fig. 25.)

A perennial, *spreading somewhat by rootstocks*, with an erect or somewhat geniculate culm about 7–10 cm. tall, puberulent just below the nodes. Sheaths *glabrous;* ligule *3–4 mm. long*, truncate, entire or somewhat lacerate-dentate; blades linear-lanceolate, *glabrous or slightly scabrous*, about 15–20 cm. long and 4–7 mm. broad. Panicle broad, lax, drooping, about 15–20 cm. long, lower branches 2–4. Spikelets drooping, narrow, terete, acuminate at first, 5–9-flowered, 2.5–3.5 cm. long; empty glumes smooth, the lower acute, 3-nerved, 6–8 mm. long; the upper 5-nerved, broader, 9–11 mm. long; flowering glume obtuse, 7-nerved, *12–15 mm. long, densely ciliate-pubescent on the margin nearly to the apex and also on the back at the base;* apex hyaline, emarginate, usually brownish yellow; awn straight, 3–4 or rarely 5 mm. long; palea about 2 mm. shorter than its glume.

Type No. 178, collected by W. N. Suksdorf on the Columbia River, West Klickitat Co., Washington.

General distribution: Mostly in the Coast Range and Cascade Mountains, California, north to Washington.

Specimens examined.—*California:* Hood's Peak (Bioletti 112); Black Mt. (C. Rutter 1); San Jose (Miss Bush); Borax Lake (J. Torrey 574—a poor specimen, somewhat doubtful); Pitt River, Shasta Co. (H. E. Brown 279); Head of Russian River (J. W. Blankinship 41); Agricultural Station, Amador Co. (Geo. Hansen 610); no locality (G. R. Vasey). *Oregon:* Grant's Pass (T. Howell 250).

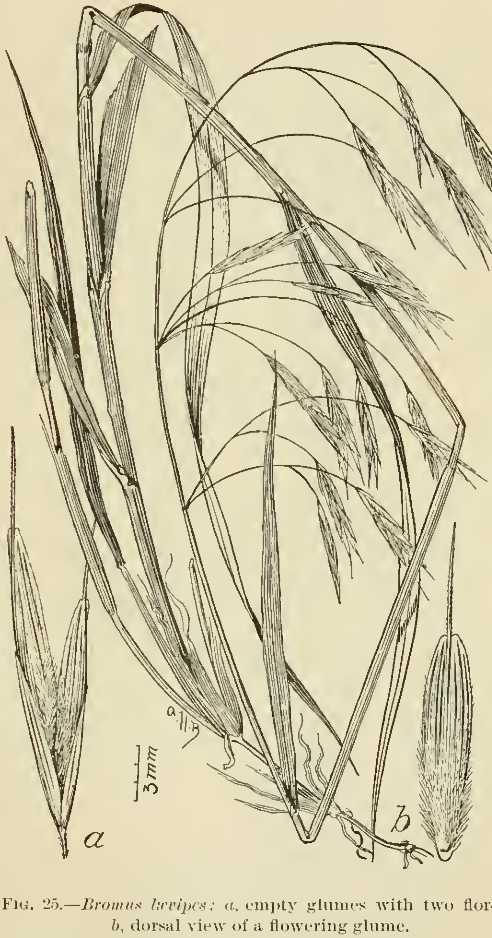

Fig. 25.—*Bromus lævipes: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

This species is closely related to *B. vulgaris*, *B. orcuttianus* and *B. richardsoni pallidus*. From the first it is distinguished by its smooth leaves and sheaths and much stouter habit, as well as broader spikelets and denser pubescence of the flowering glume. From the second it differs in the larger drooping panicle and different distribution of pubescence on the flowering glume. It appears closest to the third, *B. richardsoni pallidus*, into which it probably intergrades. It differs in its typical form from that in its much more robust habit and more pubescent flowering glumes; also in its geniculate base and the production of a rootstock.

B. *Panicle narrow, erect or nearly so, spikelets usually larger than in A, and the pubescence on the flowering not evenly distributed.*

25. BROMUS SUKSDORFII Vas. Bot. Gaz. **10**: 223. 1885. (Fig. 26.)

An erect, coarse, tufted, leafy perennial, 6–10 dm. high. Culm smooth or puberulent just below the nodes. Sheaths smooth; ligule about 1 mm. long, *subcoriaceous*, truncate, dentate; *blades mostly 5–6, broadly linear-lanceolate, rather abruptly acuminate, 1–2 dm. long, 8–11 mm. broad, firm and smooth.* Panicle narrow, erect, *rather dense*, mostly 8–13 cm. long, lower branches 2–5, *longest 2–4 cm. long, erect or ascending.* Spikelets 5–9-flowered, 2–3 cm. long, terete at first, becoming somewhat lanceolate at flowering; pedicels *shorter than the spikelets;* empty glumes glabrous or scabrous on the nerves, the lower lanceolate-acuminate, 1-nerved or sometimes with a short faint lateral nerve on each side, 8–10 mm. long, the upper broader, subacute, 3-nerved, 10–12 mm. long; flowering glume oblong-lanceolate, subacute, *12–14 mm. long* with 3 prominent nerves and frequently 2 other very faint ones on each side, *appressed-pubescent from the lateral nerves to the margins and on the midnerve about halfway up the back,* other portions smooth or scabrous, emarginate at the apex; awn 2–4 mm. long; *palea little more than three-fourths the length of its glume.*

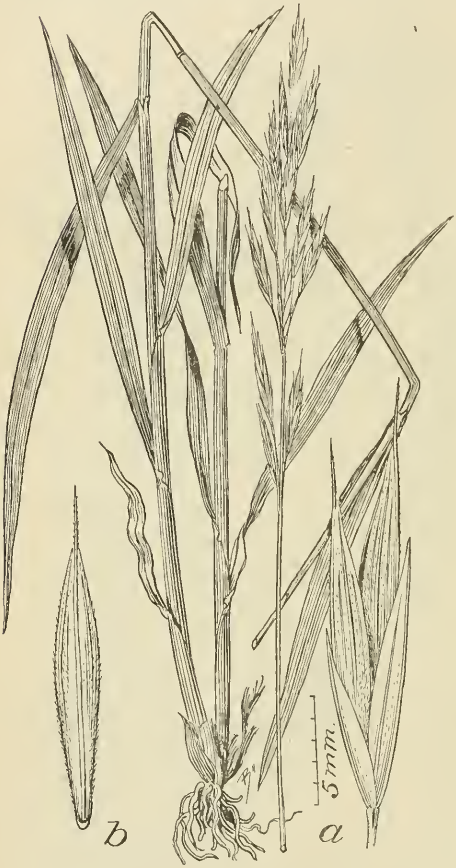

Fig. 26.—*Bromus suksdorfii: a,* empty glumes with two florets; *b,* dorsal view of a flowering glume.

Type No. 74, collected by W. N. Suksdorf "in loose soil on dry mountain sides," Mt. Adams, Washington.

General distribution: Mountains of Oregon and Washington.

Specimens examined.—*Oregon:* Crater Lake (Coville & Leiberg 423); Powder River Mt. (C. V. Piper 2523); Ashland Butte (T. Howell 249); (W. C. Cusick 1075).

This species is closely related to *B. pumpellianus*, but differs in lacking the creeping rootstock and in having a denser panicle, longer flowering glume with shorter pubescence and shorter palea. The spikelets are also narrower in flower and greenish straw color.

26. BROMUS ERECTUS Huds. Fl. Angl. 39. 1762. *Bromus macounii* Vas. Bul. Torr. Bot. Club, **15**: 48. 1888. (Fig. 27.)

A caespitose perennial with narrow leaves and an erect subsimple panicle. Culms about 6–9 dm. high, erect, glabrous. Sheaths sparingly pilose or nearly glabrous; ligule about 1.5 mm. long; blades somewhat rigid, narrowly linear, sparingly pubescent or somewhat ciliate, *the radical conduplicate*, those of the stem somewhat broader, about 1–2 dm. long. Panicle about 1–2 dm. long, narrow, pyramidal, branches erect or ascending. Spikelets fusiform-cylindric before flowering, afterwards oblong-lanceolate and somewhat laterally compressed, 5–10-flowered, sometimes purplish; empty glumes acuminate, usually scabrous on the nerves; the lower 1-nerved, 6–8 mm. long; the upper 3-nerved, 8–10 mm. long; flowering glume 10–12 mm. long, 5-nerved, oblong-lanceolate, acuminate, shortly bidentate with narrow scarious margins and apex *evenly scabrous-pubescent on the back;* awn straight, slender, 5–6 mm. long. An adventive species from Europe.

Specimens examined—*Ontario:* Kingston (J. Fowler in 1895). *Vermont:* (C. G. Pringle in 1877).

This species is reported in Britton & Brown. Ill. Fl., as being introduced in waste places about New York. The specimen collected by J. Macoun, No. 76, Vancouver Island, and named *B. macounii* by Vasey, seems to us a mere form of this species, differing only in its somewhat narrower and more rigid panicle. This species is nearly related to *B. pumpellianus.*

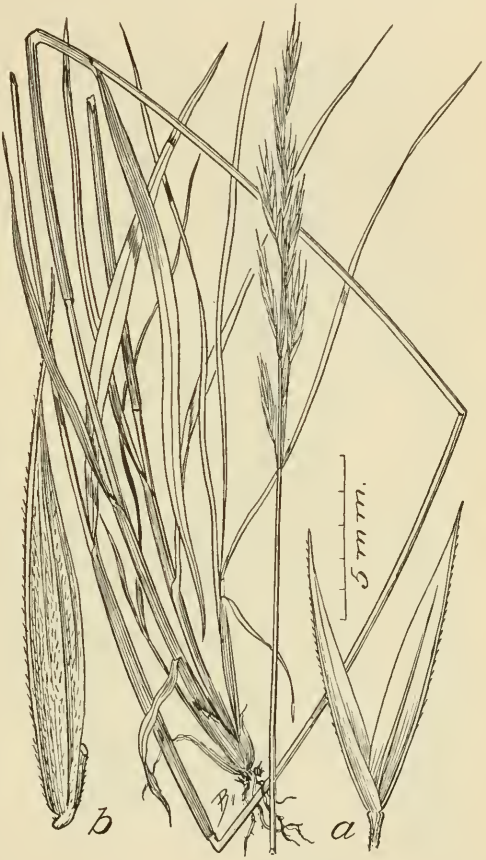

Fig. 27.—*Bromus erectus: a*, empty glumes; *b*, lateral view of the flowering glume with a joint of the rachilla.

27. BROMUS INERMIS Leyss. Fl. Hal. 16. 1761. *Schedonorus inermis* Beauv. Agrost. 99. 1812. (Fig. 28.)

An erect, smooth perennial with a creeping rootstock and erect, *broadly pyramidal or subcorymbose panicle.* Culm rather stout, smooth, about 5–9 dm. high. Sheaths smooth; ligule 1.5–2 mm. long, subtruncate, somewhat lacerate; blades linear-lanceolate, flat, smooth, or minutely scabrous, about 1.5–2.5 dm. long and about 5–10 mm. broad. Panicle rather dense, somewhat diffuse, 10–20 cm. long. Spikelets erect or somewhat drooping, *narrow, terete, about 2–2.5 cm. long and 4–5 mm. wide after flowering;* empty glumes smooth, the lower narrow, acute, 1-nerved, 4–5 mm. long, the upper subacuminate, 3-nerved, about 6–8 mm. long; flowering glume obtuse, emarginate, 5-nerved, *about 9–12 mm. long, typically glabrous*, but sometimes ciliate-pubescent on the lower half of the margins and the midrib, muticous or with an awn sometimes reaching 3 mm. long; palea equaling the glume.

General distribution: This species, which has been introduced from Europe under the name of smooth or Hungarian brome-grass, is being grown in many places throughout the semiarid regions of the West, where it is to be met with as an escape from cultivation.

It is very closely related to *Bromus pumpellianus*, but has narrower panicles and spikelets, also smoother glumes.

28. BROMUS PUMPELLIANUS Scribn. Bul. Torr. Bot. Club **15** : 9. Jan. 1888. *Bromus purgans purpurascens* Hook. Fl. Bor. Am. **2**: 252. 1840. Not *B. purpurascens* Del. 1813. *Bromus macounii* Vas. p. p. Bul. Torr. Bot. Club, **15**: 48. 1888. (Fig. 29.)

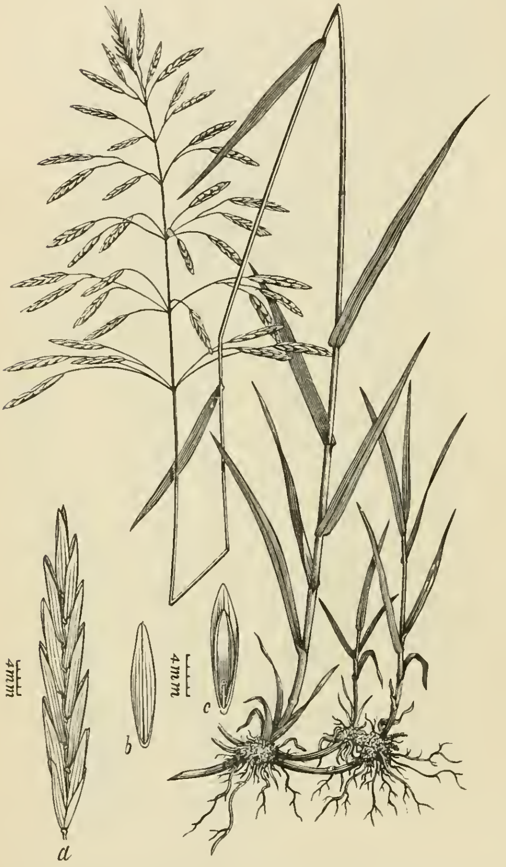

Fig. 28.—*Bromus inermis: a*, a spikelet; *c*, ventral view of a floret, showing the palea and a joint of the rachilla.

A stout, erect perennial, 6–12 dm. high, with creeping rootstocks. Culms smooth or pubescent at the nodes. Sheaths smooth or sparsely pilose-pubescent; ligule firm, truncate, rarely exceeding 1 mm. long; blades broadly linear-lanceolate, 5–10 mm. wide, 1–2 mm. long, mostly smooth below and scabrous or somewhat pubescent above, somewhat auriculate at base, point frequently involute and rigid when dry. Panicle *rather narrow, erect*, 10–20 cm. long, mostly 10–15 cm.; branches short, erect, or ascending. Spikelets mostly 7–11-flowered, 2–3 cm. long, terete-acuminate at first, somewhat laterally compressed at and after flowering, *5–7 mm. wide;* empty glumes smooth and shining, the lower 1-nerved, or rarely with two faint lateral nerves, acuminate, 6–8 mm. long, the upper broader, 7–10 mm. long, 3-nerved; flowering glume broad, ovoid-lanceolate, subacute, 5–7-nerved, 10–12 mm. long, *densely and coarsely ciliate-pubescent on the margin, nearly or quite to the apex and across the back at the base;* apex slightly emarginate; awn mostly 2–3 mm. long, rarely reaching 4–5 mm. long, or occasionally nearly or quite muticous; palea *nearly equaling its glume;* rachilla slender, pilose-pubescent.

Type No. 418, collected by F. Lamson-Scribner in the Belt Mountains, Montana.

General distribution: Colorado to South Dakota north to western Alaska.

Specimens examined.—*Colorado:* Dillon (C. L. Shear 1068½); Penns Gulch (G. W. Letterman 93); El Paso County (G. W. Letterman 38); Pikes Peak (C. L. Shear 771); Villa Grove (C. L. Shear 885); Breckenridge (C. L. Shear 1082); Veta Pass

(G. Vasey); no locality (John Wolfe 1158); Grizzly Creek (C. F. Baker 14); Como Park (C. L. Shear 1092). *Wyoming:* Sundance (T. A. Williams 2602, D. Griffiths 423); Bear Lodge (T. A. Williams 2629); Inyan Kara Mountain (D. Griffiths 634); Big Horn Mountains (W. H. Forwood). *South Dakota:* Custer (David Griffiths 700); Elk Creek, Black Hills (P. A. Rydberg 1167); Sylvan Lake (D. Griffiths 719, 708). *Montana:* Columbia Falls (R. S. Williams); Gallatin River Canyon (J. W. Blankinship); Black Hawk (P. A. Rydberg 3271); Dry Fork Belt Creek (P. A. Rydberg 3356); Barker (P. A. Rydberg 3362, 3383). *British America:* Rocky Mountains (J. Macoun 14); Fort Ellice (J. Macoun 104). *Alberta:* Near Banff (J. Macoun 23, 30); Benton Trail, Milk River (J. Macoun 13051); Devils Head Lake (J. Macoun 25, 27); Elbow River (J. Macoun 18638); Crow Nest Pass (J. Macoun 18639). *Saskatchewan:* Prince Albert (J. Macoun 13050); Saskatchewan Plains (J. Macoun 78). *British Columbia:* Kicking Horse Lake (J. Macoun 15). *Alaska:* Fort Yukon (O. S. Bates).

This plant is closely related to *B. erectus* and also to *B. inermis*, both of which are only found in this country as introduced or adventive species. Our species, which is rather frequent in the Rocky Mountains from Colorado north, reaches Alaska and probably connects with *B. inermis* in eastern Siberia. Our plants can usually be distinguished from *B. erectus* by their broader spikelets, longer awns, and the coarse ciliate-pubescent margins and bases of the flowering glumes. The leaves of the sterile shoots or innovations of *B. erectus* are narrow and involute and the plant cæspitose. In the case of *B. inermis* the relationship is closer and the separation more difficult. Generally our species has a narrower, denser, more rigidly erect panicle with shorter branches and broader spikelets. The flowering glumes are more coarsely and densely ciliate-pubescent and very rarely muticous. The difficulties of separating these species are likely to be greatly increased in the future by the rapid distribution of the cultivated forms of *B. inermis* in the region occupied by *B. pumpellianus* and also by the probability of hybridization of the two plants. Judging from the description and a single spikelet from the type of Hooker's *B. purgans purpurascens*, collected by Dr. Richardson in the region of Bear Lake, British America, it is the same as our plant.

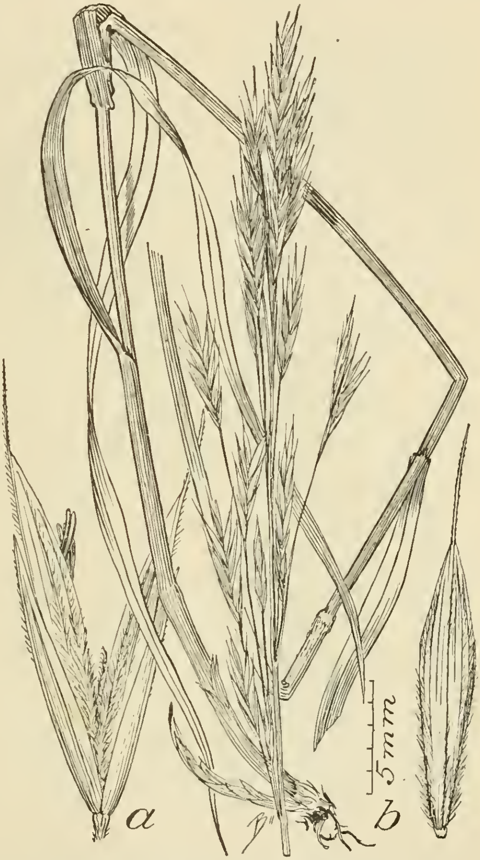

FIG. 29. *Bromus pumpellianus:* *a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

28α. **BROMUS PUMPELLIANUS TWEEDYI** Scribn. in Beal, Grass. N. A. **2**: 622. 1896.

This differs from the species in having the leaves and sheaths usually pilose-pubescent throughout and the flowering glumes with coarser, denser, hirsute-pubescence. In other respects like the species.

Type No. 587, collected by Frank Tweedy, Slough Creek, Yellowstone Park.

General distribution apparently the same as for the species.

Specimens examined.—*Colorado:* (H. N. Patterson 29); (M. E. Jones.) *Wyoming:* Sundance (D. Griffiths 435, 884); Meeteetse Creek (T. A. Williams 2917); Welcome (T. A. Williams 2673, 2682); Bear Lodge (T. A. Williams 2655). *Montana:* Lima (P. A. Rydberg 2309, C. L. Shear 568). *Alaska:* Yukon River (Dawson 92).

28β. **BROMUS PUMPELLIANUS MELICOIDES** n. var.

This is a form having the sheaths retrorsely pilose-pubescent, especially on the lower half toward the nodes. The pubescence on the margins and of the flowering glume is rather short and scanty, and the awn is entirely wanting or sometimes 1 mm. long.

Type collected by Dr. L. H. Pammel, Beaver Creek Camp, Colorado, July 8, 1896, altitude about 3400 meters. This plant is rather intermediate between *B. pumpellianus* and *B. inermis*, but is apparently an endemic form and belongs rather with the former than the latter. The obtuse glumes, with thin, purple margins, give the plant a strong resemblance to *Melica*, whence the name.

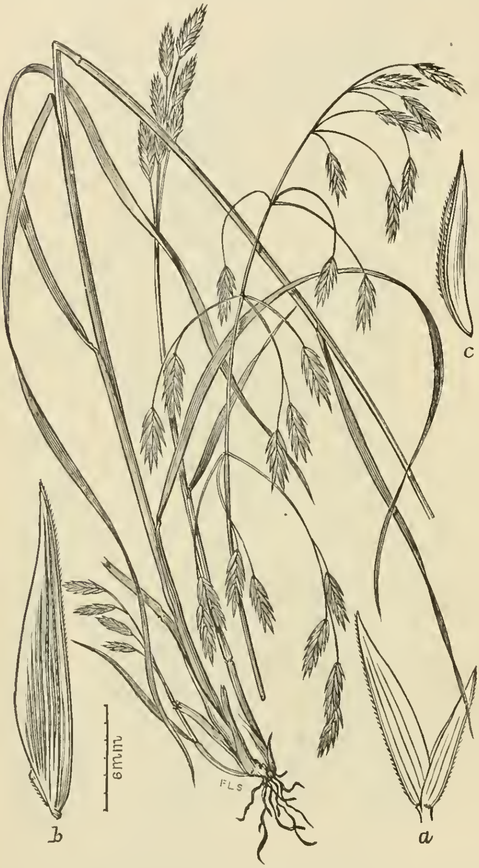

Fig. 30. *Bromus unioloides:* *a*, empty glumes; *b*, lateral view of a flowering glume.

V. CERATOCHLOA (Beauv.) Benth. & Hook.

Spikelet large, strongly compressed, and more or less keeled.

29. **BROMUS UNIOLOIDES** (Willd.) H. B. K. *Festuca unioloides* Willd. Hort. Berol. **1** : 3. *pl. 3.* 1806. *Bromus unioloides* H. B. K. (?) Nov. Gen. et Sp. Pl. **1** : 151. 1815. *Bromus carthartıcus* Vahl. (?) Symb. Bot. **2** : 22. 1791. *Ceratochloa pendula* Schrad. Linnæa, **6** : Litt. 72. 1831. *Ceratochloa schraderi* Kunth, Enum. Pl. **1** : 416. 1833. *Ceratochloa breviaristata* Hook. Fl. Bor. Am. **2** : 253. 1840.

Bromus willdenowii Kunth, Rev. Gram. **1**: 134. 1835. *Ceratochloa submutica* Steud. (?) Syn. Pl. Gram. 321. 1854. (Fig. 30.)

A rather stout annual, with erect or suberect panicle and strongly compressed oblong-lanceolate spikelets. Culms glabrous, about 5–10 dm. high. Sheaths usually pilose-pubescent, sometimes smooth, typically with a tuft of hairs at the base of the ligule; ligule about 3–4 mm. long, somewhat laciniate on the margin; blades linear, scabrous on both sides or sparingly pilose-pubescent. Panicle *usually elongated and narrow pyramidal, 1.5–3.5 dm. long;* lower branches 2–4, short in small forms, to rather long, spreading, or somewhat drooping in the larger ones. Spikelets 2–3.5 cm. long, 5–9 mm. broad, about 7–11-flowered; empty glumes broad, subacute, smooth or slightly scabrous, the lower usually 5-nerved, 7–10 mm. long, the upper usually 7-nerved, 10–13 mm. long; flowering glumes broadly lanceolate, acute, subcoriaceous, subglabrous to coarsely scabrous, slightly bidentate at the apex, about 13–16 mm. long, usually with a short stout awn, rarely exceeding 2 mm. long; *palea between one-half and three-fourths the length of its glume.*

General distribution: Alabama to California and southward. Perhaps introduced throughout most of our range. Occasionally met with in other Southern States.

Type grown at Berlin from seed sent from Carolina.

Specimens examined.—*Alabama:* Montgomery (C. Mohr in 1868); Auburn (Earle & Baker 1502). *Louisiana:* Calhoun (C. R. Ball 76). *Texas:* San Antonio (A. W. Barr 1873); Riddleville (W. S. Ruckman in 1885). *New Mexico:* (A. Fendler 918—an immature plant approaching *B. polyanthus paniculatus*). *Arizona:* Pipe Spring (M. E. Jones 5272i); Tucson (J. W. Toumey 28). *California:* Kern County (A. B. Leckenby in 1896).

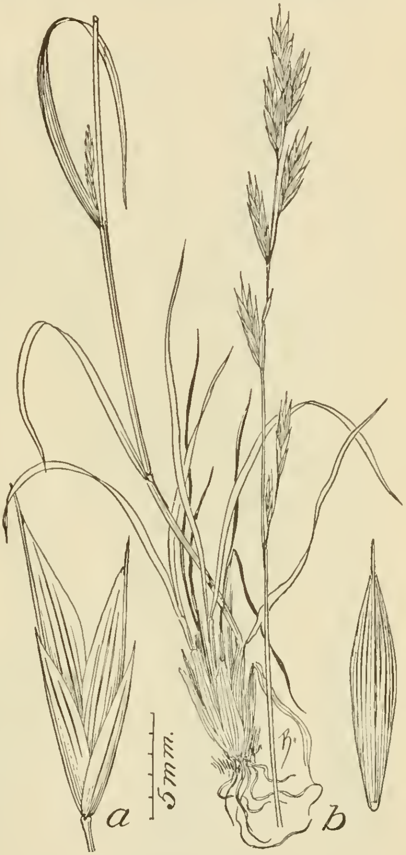

Fig. 31.—*Bromus unioloides hænkeanus: a,* empty glumes with two florets; *b,* dorsal view of a flowering glume.

Bromus catharticus Vahl, l. c., judging from the original description, is but a mere form of this species, and were it not for the reference to Feuillée's plate (Jour. Obs. Phys., etc., de l' Amèrique Merid. & Ind. Occ. 1) as representing the plant, we should not hesitate about adopting the name; but after examining a tracing of the plate kindly furnished by Dr. Robinson, we are inclined to think that there is a mistake, either in our interpretation of Vahl's description, or in his reference to Feuillée's plate, as that does not represent our plant. Only an examination of Vahl's type will settle the question conclusively. *Bromus submuticus* Steud l. c., collected at St. Louis, judging from the original description, belongs here. We have been unable thus far to locate the type specimen, so the matter still remains in some doubt.

An examination of a spikelet from the type of *Ceratochloa breviaristata* Hook. proves conclusively that this is a mere short-awned form of *B. unioloides.* It is possible that the locality cited, "on the dry elevated ground of Lewis and Clarkes River, and near the sources of the Columbia," may be the result of a confusion of labels. The plant, if found there, must almost certainly have been an adventitious one, which seems to us scarcely probable at that time—1826.

This species has been in cultivation so long that its endemic distribution is difficult or impossible to determine.

29*α*. BROMUS UNIOLOIDES HÆNKEANUS (Presl.) n. comb. *Ceratochloa hænkeana* C. B. Presl in J. S. Presl, Reliq. Hænk. **1:** 285. 1828. (Fig. 31.)

An annual or biennial plant differing from the species in its smaller size, being about 1.5–5 dm. high, and narrow, erect, subracemose panicle 5–10 cm. long, with somewhat smaller spikelets. The leaves are narrow, linear, pilose, pubescent, both sides and sheaths retrorsely pilose. Type collected "in Cordilleris chilensibus, inque montanis Peruviæ." General distribution: Florida to southern California.

SPECIMENS EXAMINED.—*Florida:* Madison (R. Combs 247—a form with somewhat pubescent glumes). *Alabama:* Mobile (T. H. Kearney 16). *Texas:* Bexar County (G. Jermy 229); Hempstead (E. Hall 792); (J. Reverchon 119); Dallas (J. Reverchon 1105); Fort Clark (E. A. Mearns 1273); Corpus Christi (A. A. Heller 1497). *California:* Mentone (J. B. Leiberg 3296). Our specimens are like specimens from the type collection in the Bernhardi herbarium at the St. Louis Botanical Gardens (cf. Rept. Mo. Bot. Gard. **10:** *pl. 54. f. 1.* 1898) except that the sheaths are more pilose.

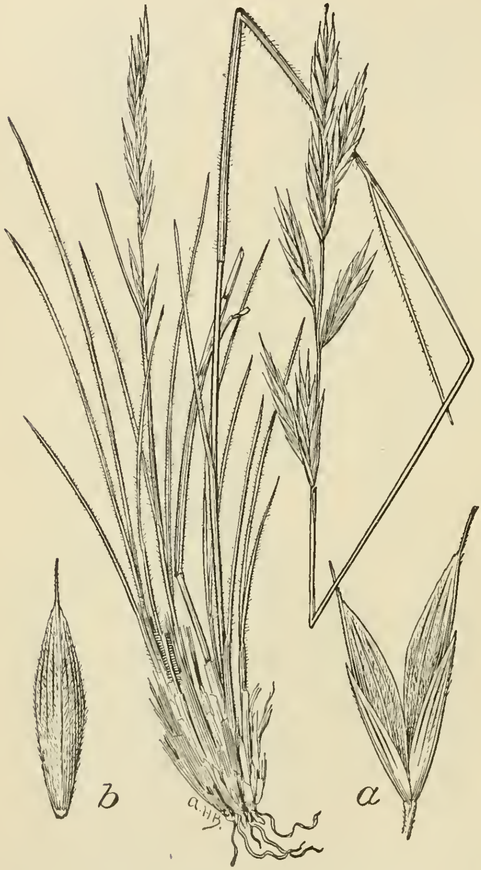

FIG. 32.—*Bromus subvelutinus: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

30. BROMUS SUBVELUTINUS n. sp. (Fig. 32.)

An erect, tufted perennial. Culm somewhat puberulent above, about 2.5–5 dm. high, *densely clothed at the base with the old sheaths.* Sheaths *canescent;* ligule about 1 mm. long, truncate, laciniate; blades *narrow, linear, rather rigid, becoming involute, canescent and also pilose with spreading hairs,* those of the culm 4–10 cm. long, those of the innovations longer. Panicle about 5–10 cm. long, narrow, erect, simple, sometimes bearing but a single spikelet, or the lower branches in pairs and about 1–3 cm. long. Spikelets 5–7 flowered, 2–3 cm. long, laterally compressed, becoming rather turgid at maturity; empty glumes subobtuse, puberulent, the lower 3–5-nerved, 8–10 mm. long, the upper 7-nerved, 10–12 mm. long; flowering glume *appressed-puberulent*, indistinctly 7-nerved, 12–15 mm. long, with two short, rather obtuse, hyaline teeth and a *stout awn 3–4 mm. long;* palea short pectinate-ciliate on the keels, about 3 mm. shorter than its glume.

Type No. 249, S. M. Tracy, collected at Reno, Nevada, in 1887.

Distribution: Nevada and California.

SPECIMENS EXAMINED.—Nevada: l. c. *California:* Grassy mountain slope, Fort Tejon (S. B. Parish No. 1995).

This plant is most closely related to *B. marginatus* from which it is distinguished chiefly by the narrow, rigid, involute leaves, canescent leaves and sheaths, and somewhat caespitose habit. It seems to be peculiar to arid regions.

31. BROMUS MARGINATUS Nees in Steud. Syn. Pl. Gram. 322. 1854. *Bromus breviaristatus* Buckl. and most auct. amer. Not *Ceratochloa breviaristata* Hook. *Bromus pauciflorus* Nutt. in Herb. Acad. Nat. Sci. Phil. (Fig. 33.)

An erect, tufted, rather stout, short-lived perennial. Culm 6–12 dm. high, mostly puberulent or pubescent. Sheaths *pilose-pubescent;* ligule 3–3.5 mm. long, subrotund, laciniate; blades broad, linear-lanceolate, *somewhat sparsely pilose-pubescent throughout*, rather rough and coarse, 1.5–2.5 dm. long, 6–12 mm. wide. Panicle erect, rather narrow, mostly 1–2 dm. long; *lower branches 2–4, erect, or somewhat spreading in flower, unequal, lowest rarely more than 7 cm. long and bearing 2 spikelets.* Spikelets 2.5–4 cm. long, 5–7 mm. wide, oblong-ovoid to oblong-lanceolate, laterally compressed, somewhat turgid at maturity, mostly 7–9-flowered, erect or ascending, the uppermost subsessile; empty glumes, *rather broad, scabrous to scabrous-pubescent;* the lower subacute, 3–5-nerved, mostly 7–9 mm. long; the upper broader, obtuse, 9–11 mm. long, 5–7-nerved, the lateral nerves broad; flowering glume, *subcoriaceous, coarsely pubescent*, ovate-lanceolate, acute, 11–14 mm. long, mostly 7-nerved, with two very short hyaline, *subacute teeth at the apex and a rather stout straight awn 4–7 mm. long;* palea ciliate-pectinate on the keels, almost or quite equaling its glume.

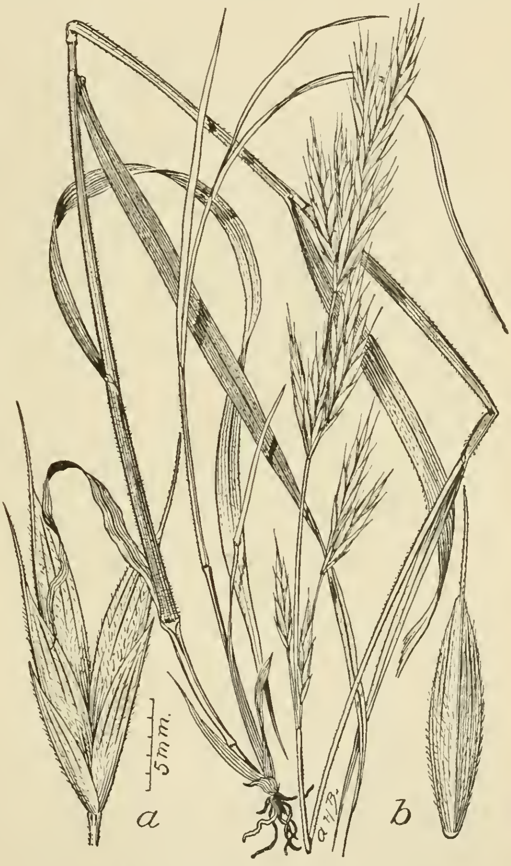

FIG. 33.—*Bromus marginatus:* *a*, empty glumes with three florets; *b*, dorsal view of a flowering glume.

Type collected by Douglas "on the Columbia River, St. Louis." The reference to St. Louis is evidently either an error or else refers to some locality on the Columbia not at present recognized in our atlases.

General distribution: Arizona and Colorado to Alberta and west to the Pacific.

SPECIMENS EXAMINED.—*Arizona:* (Dr. E. Palmer in 1869; 535 in 1876); Grand Canyon, (D. T. McDougal 181); Tucson (J. W. Toumey 752½). *Colorado:* (C. S. Crandall 523). *Wyoming:* Sundance (T. A. Williams 2611, 2612, and Griffiths 434, 911); Meeteetse Creek (T. A. Williams 2904); Bear Lodge (Williams 2655a); Little Laramie River (Williams 2322, 2230, and Aven Nelson 3333); Powder River (T. A. Williams 2799); Spring Creek (T. A. Williams 2813½, J. N. Rose 698); Sherman (G. W. Letterman 81); Parkman (Aven Nelson 2457); Sheridan (L. H. Pammel 1897); Hewlett (D. Griffiths 932); Beulah (Griffiths 970); Little Missouri Buttes (D. Griffiths 585); Medicine Bow River (A. Nelson 4073). *Yellowstone National Park:* Soda Butte (F. Tweedy 586). *Montana:* Bozeman (C. L. Shear 449, P. A. Rydberg 3006, 3000); Lima (C. L. Shear 569, P. A. Rydberg 2314); Mystic Lake (P. A. Rydberg 2247); Boulder Creek (F. Lamson-Scribner 4); Castle (P. A. Rydberg 3252, 3259); Spanish Creek Basin (P. A. Rydberg 3199, T. A. Williams 2007, 2039); Dry Fork Belt Creek (P. A. Rydberg 3355); Deer Lodge (P. A. Rydberg 2119, C. L. Shear 378); Manhattan (C. L. Shear 415); Columbia Falls (R. S. Williams 604). *Alberta:* St. Mary's River (J. Macoun 13038). *British Columbia:* Lower Frazer River, 49° north latitude (Dr. Lyall in 1859). *Idaho:* Nez Perces County (Sandberg, Heller, and McDougal 331); Hatwai Creek (L. F. Henderson 2828). *Washington:* (Sandberg & Leiberg 450); Pullman County (A. D. E. Elmer 253); Yakima (A. B. Leckenby 1898); Blue Mountains (C. V. Piper 2565); Columbia River, Klickitat County (W. N. Suksdorf 174); Waitsburg (R. M. Horner 568); Walla Walla (C. L. Shear 1593). *Oregon:* Elgin (C. L. Shear 1734); east side Harney Valley (J. B. Leiberg 2370); above Wallowa Lake (C. L. Shear 1803); Gearhart (C. L. Shear 1695, W. C. Cusick 650a). *Nevada:* Diamond Mountains (S. Watson 1327); Virginia Mountains (S. Watson 1326); Reno (S. M. Tracy 224). *California:* (J. G. Lemmon 1875); San Francisco (F. Lamson-Scribner in 1899); Mission Hills (Michener and Bioletti 123).

The original description of the above species, which is quoted in full below, applies so well to the specimens referred to, that taken in connection with some other circumstances, we feel little hesitation in taking it up. So far as we know, it has not before been recognized, except by Fournier (Mex. Pl. **2:** 127), who seems to have somewhat misinterpreted it.

The plant has been generally referred to *Bromus breviaristatus* (Hook.) Buckl. l. c. It is the same as the specimen of *Bromus pauciflorus* Nutt. in Herb. Acad. Nat. Sci. Phil., upon which *B. breviaristatus* Buckl. was founded. Hooker appears to have included it in his *Ceratochloa breviaristata*, as there is a spikelet of it in the Gray Herbarium, which Dr. Gray has marked "original spec." The distribution of this plant by Hooker under the name *breviaristata* led Torrey, Gray, and Thurber to a misinterpretation of the species, for as already mentioned under *B. unioloides*, Hooker's drawing and type clearly belong to that species.

We have been unable as yet to locate Nees's type specimen; but the fact that Hooker distributed this plant from Douglas's collection, taken in connection with the fact as shown in a season's work in the region of the Columbia that this species and its varieties are the most common bromes met with, there is left little doubt that we have the plant Nees described.

This species is quite variable. Toward the north it passes into *B. aleutensis* Trin., and southward into *B. polyanthus*, while near the Pacific coast it passes through var. *latior* into *B. carinatus*.

Index Kewensis gives this as a synonym of *B. ciliatus* L., but this is evidently a mistake. The following is the original description taken from Steudel l. c.:

"*Bromus marginatus* Nees (mpt. sub.: *Ceratochloa*).

"Foliis vaginisque hirsutis; paniculæ erectæ strictæ radiis subsimplicibus; spiculis oblongo-lanceolatis compressis utrinque convexis pubescenti-scabris 6–8-floris; seta valvula sua 7-nervia duplo breviore. ♃ Douglas legit ad fluv. Columbia St. Louis."

31*a*. BROMUS MARGINATUS LATIOR n. var.

A larger and stouter plant than the species, sometimes reaching 17 or 18 dm. high. Panicle larger, 2–3 dm. long, with longest lower branches 10–20 cm. long, awn usually slightly longer, sometimes reaching 6 or 7 mm. Otherwise like the species.

Type No. 1615, collected by C. L. Shear, Walla Walla, Washington.

General distribution about the same as for the species, but in lower altitudes, being most common in the foothills and valleys down to about 1,600 meters.

Specimens examined.—*New Mexico:* Santa Fe (Dr. George Vasey). *Utah:* Springdale (M. E. Jones 5242). *Colorado:* Ft. Collins (L. H. Pammel). *Arizona:* Little Laramie River (T. A. Williams 2233). *Wyoming:* Bozeman (C. L. Shear 476; P. A. Rydberg 2213); no locality (J. W. Blankinship); Sheep Creek (P. A. Rydberg 3308; F. L. Scribner 16); Spanish Creek (P. A. Rydberg 3337); East Gallatin Swamp (P. A. Rydberg 3171); Spear Basin (P. A. Rydberg 3155). *Idaho:* head of Little Potlatch River (Sandberg, Heller, & McDougal 434, 331); Lewiston (A. A. & E. G. Heller 3202); Moscow (L. F. Henderson 2829); St. Josephs River (J. B. Leiberg 1298). *Washington:* Walla Walla (C. L. Shear 1615); Pullman (C. V. Piper 1738). *Oregon:* (W. C. Cusick 650); Prineville (J. B. Leiberg 314). *California:* (J. G. Lemmon).

This plant has been collected by wool waste heaps at North Berwick, Maine. It is also escaped from cultivation about Ames, Iowa, from which place it is represented in the herbarium by C. R. Ball's Nos. 33 and 148.

Forms of this plant in Oregon and Washington connect with *B. carinatus hookerianus*, which is generally distinguished by its smoother spikelets and longer awns.

31*β*. BROMUS MARGINATUS SEMINUDUS n. var.

This differs from the species in the following particulars: Usually more leafy, but less pubescent or, in some cases, nearly smooth throughout; spikelets with empty glumes glabrous or slightly scabrous on the nerves; flowering glumes somewhat scabrous or scabrous-puberulent.

Type No. 1811 C. L. Shear, collected on open mountain side 5 miles above Wallowa Lake, Oregon.

Distribution about the same as for the species.

Specimens examined.—*Utah:* Santa Clara (M. E. Jones 5118b); Ogden (T. A. Williams 2477; S. M. Tracy 322). *Wyoming:* Sherman (L. H. Pammel); Bear Lodge (T. A. Williams 2648, 2633); Sundance (D. Griffiths 984); Spread Creek (F. Tweedy 64). *Idaho:* Beaver Canyon (C. L. Shear 573); Forks of Boise River (L. F. Henderson 3271). *Yellowstone National Park:* (J. N. Rose 222). *Montana:* Spanish Creek (P. A. Rydberg 3028, 3104); Gallatin County (F. Tweedy); Bridger Pass (P. A. Rydberg 3219); Bozeman (P. A. Rydberg 2233½). *Assiniboia:* Cypress Hills (J. Macoun 13040). *Washington:* (G. R. Vasey; Kirk Whited 2, 4); Montesano (A. A. & E. G. Heller 3979). *Oregon:* Mountains above Wallowa Lake (C. L. Shear 1811, 1789, 1777, 1785, 1803, 1810, 1794, 1815, 1766, 1775, 1796); Wallowa Lake (C. L. Shear 1751, 1762); Hood River (L. F. Henderson); Hoover Creek (J. B. Leiberg 138); Government Meadows, Blue Mountains (C. L. Shear 1668, 1666); Blue Mountains (C. L. Shear 1679, 1688, 1674); Cathedral

Rocks, Crater Lake (Coville & Leiberg 379); Ravena (A. B. Leckenby); Portland (B. Killin); Grants Pass (T. Howell 251); hills northwest of Corvallis (M. Craig). *California:* (J. G. Lemmon 438; C. A. Purpus 5421); Donner Lake (L. H. Pammel); San Jacinto Mountains (H. M. Hall 785); mountains south of Dixie Valley (J. B. Davy); no locality (Vasey).

This form is the connecting link between *B. marginatus* and *B. polyanthus*. It, like the species, is a mountain plant extending up to about 3000 meters altitude or somewhat higher. In the lower altitudes the panicle tends to become longer and laxer, passing into variety *latior*.

32. BROMUS POLYANTHUS Scribn. nom. nov. *Bromus multiflorus* Scribn. U. S. Dept. Agr. Div. Agrost. Bul. **13**: 46. 1898. Not Weig. 1772, et al. (Fig. 34.)

A rather stout, erect, short-lived perennial. Culm smooth or puberulent at the nodes, mostly 6–10 dm. high. Sheaths *typically smooth*, rarely sparsely pilose; ligule about 2 mm. long, rounded, subentire; blades *linear-lanceolate, mostly scabrous, especially above*. Panicle elongate, erect, branches usually short and erect or slightly spreading. Spikelets mostly 3–3.5 cm. long, laterally compressed, carinate, rather densely 7–11 flowered; empty glumes broad, *smooth or somewhat scabrous*, the lower 3-nerved, rather obtuse or subacute, 6–8 mm. long, the upper 5–7 nerved, most obtuse, 9–11 mm. long; flowering glume 7 nerved, 13–15 mm. long, *smooth or scabrous*, rather obtuse, emarginate with a broad, hyaline margin; awn 4–6 mm. long; palea a little shorter than its glume.

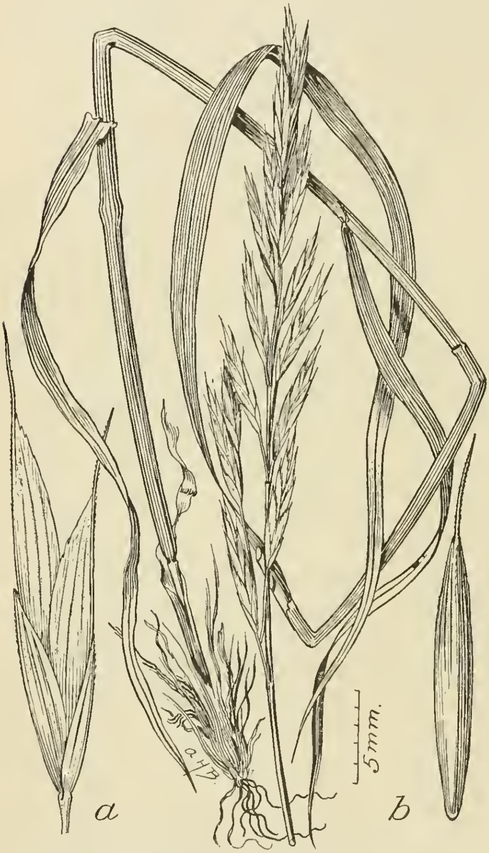

Fig. 34.—*Bromus polyanthus: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

Type No. 4024, collected by Aven Nelson at Battle Lake, Sierra Madre Mountains, Wyoming.

General distribution: Colorado and Utah north to Montana and Oregon.

Specimens examined.—*Colorado:* Glenwood Springs (Shear & Bessey 1300); Buffalo Pass (Shear & Bessey 1434, 1474, 1484); Yampa (Shear & Bessey 1421); Red Dirt Divide, Routt County (Shear & Bessey 1347, 1362, 1385); near Pallas (Shear & Bessey 1411); Middle Park (G. Vasey); Robinson (C. L. Shear 1045); Rabbit Ears Pass (C. F. Baker 4). *Utah:* Logan (P. A. Rydberg 2347); Alta (M. E. Jones 1111); Fairview (M. E. Jones 5554m). *Idaho:* Beaver Canyon (C. L. Shear 596;

P. A. Rydberg 2342); Montpelier (T. A. Williams 2553). *Wyoming:* Bear Tooth Mountains (W. H. Forwood); Bear Lodge Mountains (T. A. Williams 2619); Jacksons Lake (W. H. Forwood); Elk Mountain (A. Nelson 4098); Buffalo Fork (F. Tweedy 65); Rife's Ranch (A. Nelson 3759, 3827); Seminole Mountains (A. Nelson 4921); Sierra Madre Mountains (A. Nelson 4035). *Montana:* Lima (C. L. Shear 560½). *Oregon:* Powder River Mountains (C. V. Piper 2529).

The above species is very closely related to *B. marginatus,* into which it passes and of which it should perhaps be regarded as a variety. It differs chiefly from the typical form of *B. marginatus* in being smoother throughout.

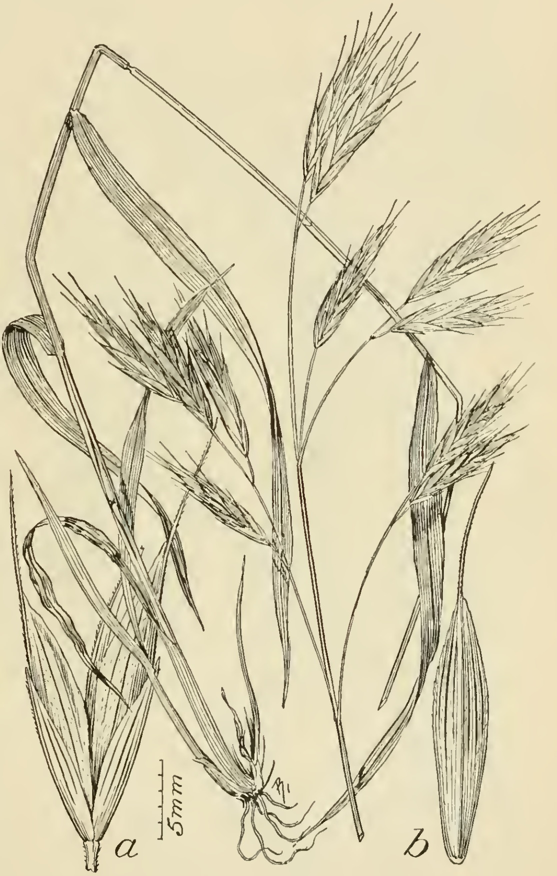

Fig. 35.—*Bromus aleutensis:* *a,* empty glumes with two florets; *b,* dorsal view of a flowering glume.

32*a*. **BROMUS POLYANTHUS PANICULATUS** n. var. (Fig. 35.)

A rather tall, leafy plant with a larger, laxer, more spreading panicle than the species and having the upper part somewhat nodding. The leaves are rather broader and the spikelets slightly narrower, with the florets rather looser in flower and the awn sometimes reaching 7 mm. long.

Type No. 333 Tracy, Earle, and Baker, collected in West Mancos Canyon, Colorado, altitude about 3,000 meters.

Specimens examined.—*Colorado:* West Mancos Canyon (Baker, Earle and Tracy 333); Trimble Springs (Baker, Earle & Tracy 4301); Parrott (Baker, Earle & Tracy 4297); Buffalo Pass (Shear & Bessey 1493); Sheep Horn Divide (Shear & Bessey 1552); La Veta (C. L. Shear 812). *Utah:* Gunnison (L. F. Ward 286). *Arizona:* Strawberry Creek (D. T. McDougal 707).

This plant bears the same relation to the species that *B. marginatus latior* does to its species. Its distribution is more southern in general and most frequent in lower altitudes.

33. **BROMUS ALEUTENSIS** Trin. Griseb. in Ledeb. Flor. Ross. **4**: 361. 1853. (Fig. 35.)

A rather tall, stout perennial, *with a lax, suberect panicle* and broad, linear-lanceolate leaves. Culms 5–10 dm. high, erect, stout, usually slightly pubescent just below the nodes; internodes generally 3 to 4. Sheaths usually equaling or exceeding the internodes, coarsely striate, usually sparsely retrorsely pilose; ligule 4–5 mm. long, subrotund above, somewhat laciniate; blades mostly 20–35 cm. long, usually sparsely pilose on both sides. Panicle, 12–20 cm. long; lower branches *1–2, bearing 1–3 spikelets somewhat nodding*, becoming more or less rigid and erect when old. Spikelets oblong-lanceolate, compressed, 2.5–3.5 cm. long, 7–9 mm. broad, 3–6-flowered; empty glumes broad, subequal, the lower distinctly 3-nerved, subacute, upper distinctly 5 or obscurely 7 nerved, obtuse, 10–13 mm. long, usually scabrous, especially on the nerves; *flowering glume broadly lanceolate distinctly 7-nerved*, with a broad membranous margin, smooth to scabrous-pubescent, *averaging about 15 mm. long*, bidentate at the apex, awned; awn stout, scabrous, *mostly 9–11 mm. long*; palea nearly equaling its glume, acute, ciliate-pectinate on the keels. Pachilla thinly pubescent, about 3 mm. long.

General distribution: Atka and Unalaska.

Type in Herb. Ledebour from Unalaska, collected by Eschscholtz.

Specimens examined.—*Unalaska* (W. H. Evans 550 in 1897; Dr. A. Kellogg 142 in 1867; S. Applegate, no number or date; M. W. Harrington in 1871–72). *Atka* (L. M. Turner 1194 in 1880).

This species is very closely related to *B. marginatus.* The original description says "spikes glabrous," but we have amended it to include forms having scabrous-pubescent flowering glumes. Such forms coming from St. Petersburg Herb. and evidently determined by Trinius are in the Gray Herb. We have seen no specimens with perfectly glabrous spikelets.

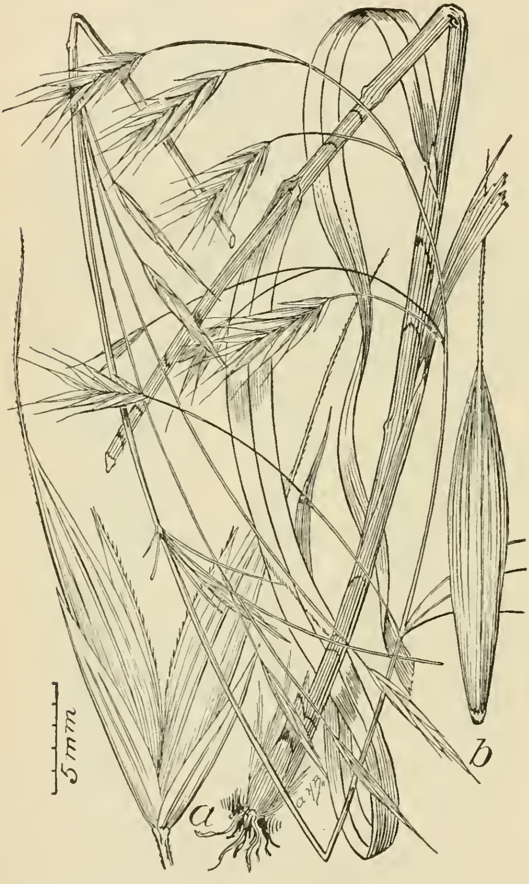

Fig. 36.—*Bromus sitchensis:* a, empty glumes with two florets showing the paleæ; b, dorsal view of a flowering glume.

34. BROMUS SITCHENSIS Bong. Obs. Veg. Sitch. 173. 1831. (Fig. 36.)

A tall, stout, leafy perennial. Culm smooth, nearly erect, 12–18 dm. high. Sheaths shorter than the internodes, *smooth;* ligule large, rounded entire or somewhat torn, 3–5 mm. long; blades *linear-lanceolate, 2–4 dm. long, 7–12 mm. broad, sparsely* *short-pilose above, smooth beneath.* Panicle *large, lax, drooping, 2.5–3.5 dm. long; lower branches 2–4, long, weak, spreading, usually bearing 1–3 spikelets on long, slender pedicels.* Spikelets 2.5–3 cm. long, 6–8 mm. wide, oblong-lanceolate, strongly laterally compressed, rather loosely flowered; empty glumes acute, smooth or scabrous on the nerves, the lower lanceolate, 3-nerved, 8–9 mm. long, the upper broader, 5–7 nerved, 10–12 mm. long; flowering glume broadly lanceolate, acute, about 12–14 mm. long, 7-nerved, smooth or scabrous, shortly bidentate at the apex, *with a straight awn 6–9 mm. long;* palea considerably shorter than its glume, short pectinate-ciliate on the keels.

Type from the Island of Sitka.

General distribution: Alaska south to Washington, apparently near the coast.

Specimens examined.—*Alaska:* Unalaska (Dr. A. Kellogg 142); Hope Island (Dr. A. Kellogg 143); Yes Bay (Thos. Howell 1722A)—a form approaching *B. aleutensis* in its shorter awn and somewhat broader flowering glume. *Cascade Mountains:* 49 n. lat. (Dr. Lyall in 1859)—a form approaching *B. carinatus hookerianus.*

This species is related to *B. aleutensis* and *B. carinatus hookerianus*, but most closely to the latter, from which it differs in the typical form in its more robust form, laxer panicle with fewer spikelets and much longer, weaker, spreading branches.

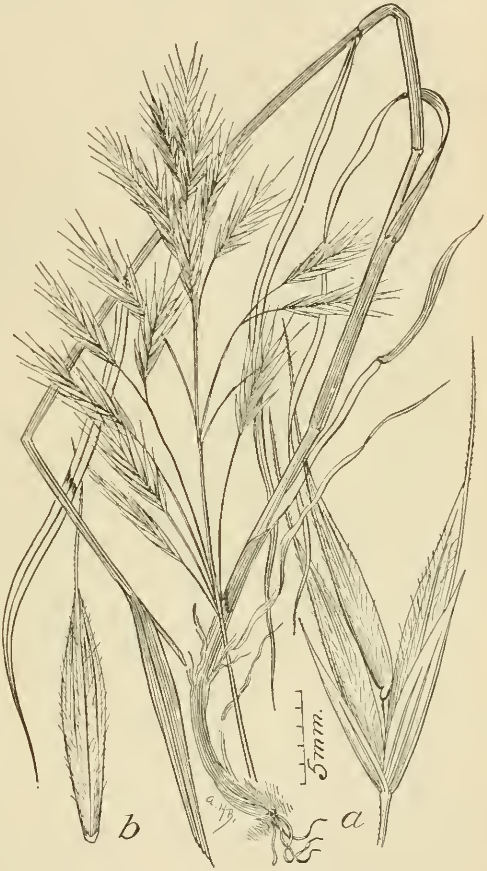

Fig. 37.—*Bromus carinatus: a*, empty glumes with three florets; *b*, dorsal view of a flowering glume.

35. BROMUS CARINATUS Hook. & Arn. Bot. Beech. Voy. Suppl. 403. 1841. *Bromus hookerianus minor* Scribn. in Beal, Grass. N. A. 2 : 614. 1896. *Bromus oregonus* Nutt. in Herb. Acad. Nat. Sci. Phil. (Fig. 37.)

An annual or biennial with erect culm, linear leaves, and erect or suberect panicle. Culm about 5–8 dm. high, slightly pubescent at the nodes. Sheaths mostly shorter than the nodes, *retrorsely soft pilose;* ligule 3–4 mm. long, sublaciniate; blades flat, *mostly narrow*, about 1–2.5 dm. long, 3–6 mm. broad, *thinly pilose both sides.* Panicle pyramidal, somewhat lax, about 1.5–2.5 dm. long; lower branches about 3, spreading, or somewhat drooping. Spikelets lanceolate to suboblong-lanceolate, compressed, *about 2.5–3 cm. long and 5 mm. broad*, 5–9 flowered; empty glumes *lanceolate, acute, glabrous to slightly scabrous-pubescent;* the lower distinctly 3 or sometimes obscurely 5 nerved, 7–9 mm. long; the upper 5 or sometimes obscurely 7 nerved, 9–11 mm. long; flowering glume lanceolate, obscurely

7-nerved, *puberulent or short-pubescent*, about 13–16 mm. long, *bifid at the apex and tapering into an awn 7–10 mm. long;* palea nearly equaling its glume, ciliate-pectinate on the keels; rachilla slender, somewhat pubescent, about 3 mm. long.

General distribution: Nevada, California, Oregon, and Washington.

Type collected by Douglas near Monterey or San Francisco, California.

Specimens examined.—*Nevada:* St. Thomas Canyon (M. E. Jones 5069x in 1894). *Washington:* western Klickitat County (W. N. Suksdorf 173 in 1885); Walla Walla (C. L. Shear 1579 in 1889); Fair Haven (C. V. Piper 2607 in 1897); Tacoma (A. B. Leckenby in 1898). *Oregon:* Eight Dollar Mountain (T. Howell in 1884, distributed as *Bromus hookerianus minor* Scribn.; 252 in 1887, large form with broad spikelets and glumes approaching *B. marginatus*); McMinnville (C. L. Shear 1617 in 1899). *California:* Santa Cruz (C. L. Anderson 128 in 1889); no locality (C. L. Anderson 120 in 1888; 76 in 1888; 96 in 1888—this specimen is about identical with specimens in the Gray herbarium from Douglas's collection which are evidently typical; 109 in 1888); Bear Valley, San Bernardino Mountains (S. B. Parish 3298 in 1894); San Bernardino Valley (S. B. and W. F. Parish 1534 in 1882); San Gorgonio (S. B. and W. F. Parish 1533—this is a rather broad-leafed, very robust form); San Diego (C. R. Orcutt 1178 in 1884; 511 in 1884); San Jose (Mrs. Bush in 1880); San Luis Obispo (Mrs. Summers); Mendocino County (J. W. Blankinship 35 in 1893); near Mendocino (H. E. Brown 747 in 1898); San Diego County (G. R. Vasey in 1880); Mariposa County (J. W. Congdon in 1895); Sonoma (E. Samuels 222); (J. M. Bigelow, Whipple expedition collection in 1853–54); Mount Hamilton (C. Rutter 92 in 1895); near Mount Shasta (E. Palmer 2626 in 1892—this is the form which Nuttall called *Bromus oregonus;* it differs from typical *B. carinatus* in its somewhat broader glumes and slightly denser pubescence); southeastern California (E. Palmer 546 in 1896); New York Falls (Geo. Hansen 627); Berkeley (J. Burtt Davy 204 in 1893); Kellogg and Harford 1113 in 1868 and 1869); Los Angeles (S. M. Tracy 168 in 1887); Laguna (L. Schoenfeldt 3624 in 1894).

35*α*. BROMUS CARINATUS CALIFORNICUS (Nutt.) n. comb. *Bromus californicus* Nutt. in Herb. Acad. Nat. Sci. Phil.

A form intermediate between typical *B. carinatus* and *B. carinatus hookerianus.* Differing from the former in its nearly smooth leaves and sheaths and its flowering glumes merely scabrous. From the latter it differs in its narrower spikelets and glumes.

Nuttall's specimen in the Philadelphia Academy herbarium labeled "n. Calif." is a mere scrap showing only two small panicles from different plants and having a few small upper leaves. This form must be near *B. hookeri schaffneri* Fourn, judging from his description.

The following specimens from southern and Lower California have been referred to this variety. *Lower California:* Todos Santos Bay (Miss F. E. Fish 12); Potrero Valley (C. R. Orcutt, in 1889). *California:* San Diego (D. Cleveland 13); (C. R. Orcutt 511a).

35*β*. BROMUS CARINATUS HOOKERIANUS (Thurb.) n. comb. *Bromus hookerianus* Thurb. in Wilkes U. S. Exp. Exped. **17**²: 493. 1874. *Ceratochloa grandiflora* Hook. Fl. Bor. Am. **2**: 253. 1840. *Bromus virens* Buckl. Proc. Acad. Nat. Sci. Phil. 98. 1862. Not *B. unioloides virens* Nees, Agrost. Braz. 470. 1829. *Bromus nitens* Nutt. in Herb. Acad. Nat. Sci. Phil. (Fig. 38.)

A robust plant, larger in all its parts than the species. Panicles erect, 2–4 dm. long; branches spreading. Spikelets 5–10 flowered, 3–4 cm. long, 5–7 mm. broad; empty glumes slightly broader and less acute than in the species; flowering glumes also broader and *scabrous* with a broad hyaline margin and an awn 10–15 mm. long.

General distribution: California to Washington and Idaho. Type in the herbarium of the Royal Gardens, Kew, England, collected on the "plains of the Columbia."

Specimens examined.—*California:* San Jose (ex herb. State Normal School); Ojai Valley (F. W. Hubby 36). *Oregon:* Gearhart (C. L. Shear 1734½, a form approaching *B. marginatus*); near Rhea Creek (J. B. Leiberg 65); (W. C. Cusick 1321). *Washington:* Klickitat County (W. N. Suksdorf 16); Seattle (C. V. Piper and E. C. Smith 944); (C. V. Piper 818). *Idaho:* Valley of Clearwater River (Sandberg, Heller & McDougal 166).

This variety passes by various intermediate forms into the species and also into *B. marginatus.* It is so inconstant in character that it does not seem advisable to try to hold it to specific rank. Through the kindness of Sir W. T. Thiselton-Dyer, director of Kew Gardens, we have been permitted to examine a spikelet from the original specimen collected by Douglas on "Upland dry soils on the Multoonah (Oregon) 1826." This leaves no doubt as to the form which Hooker took as the type of his *Ceratochloa grandiflora.*

35γ. BROMUS CARINATUS DENSUS n. var.

A tall, stout, erect plant, with a dense panicle 3 dm. long. It differs from the species in its stouter habit, smoother leaves and sheaths, the leaves being smooth or merely scabrous, and the panicle with numerous rays, some of the lower being compound and bearing many spikelets. The spikelets are narrow, 2–2.5 cm. long, with the florets subdistant, showing the slender scabrous rachilla when in flower; empty glumes as in the species; flowering glume coarsely scabrous, about 1 cm. long; awn slender, 5–7 mm. long.

Type collected by Blanche Trask "about opuntia" on San Nicholas Island, California, No. 12, April, 1897. The specimen cited shows only the panicle and the upper leaf. We should be inclined to give this specific rank but for the fact that accompanying specimens from the same island show forms connecting it with the species.

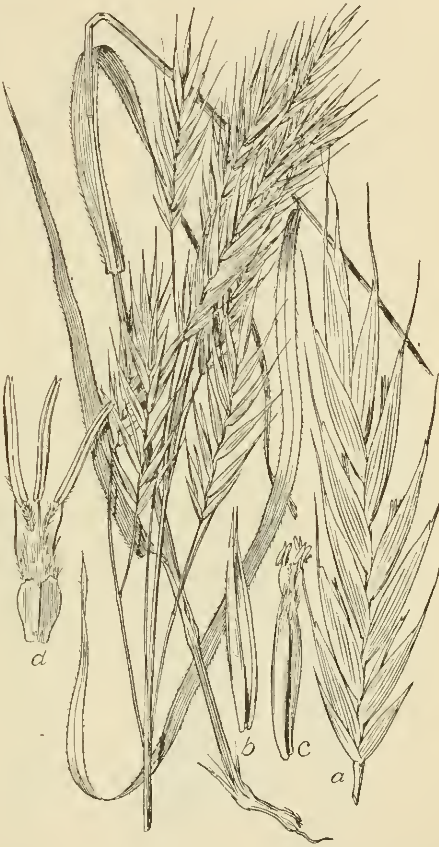

Fig. 38.—*Bromus carinatus hookerianus: a,* an entire spikelet; *b,* flowering glume without the awn; *c,* caryopsis showing plumose apex; *d,* sterile flower showing the lodicules.

35δ. BROMUS CARINATUS LINEARIS n. var. (Fig. 39.)

A somewhat cæspitose plant, with slender, nearly erect culms and very narrow linear leaves. It differs from the typical form of the species in its narrow, subracemose panicle, 5–10 cm. long, and in its shorter and narrower leaves. The spikelets are slightly broader, glumes not so acute, and awn somewhat stouter and shorter, 5–7 mm. long.

Type in the herbarium of the Department of Agriculture collected by Dr. G. R. Vasey in California in 1875.

35ε. BROMUS CARINATUS ARIZONICUS n. var.

Sheaths and leaves more scantily pilose than in the species. Panicle erect, narrow pyramidal to subracemose, spikelets and glumes slightly broader than in the species, empty glumes glabrous; *flowering glumes sparsely scabrous-puberulent,* less acute; *awn shorter, 5–6 mm. long.*

Type in the Herbarium U. S. Department of Agriculture, collected by C. G. Pringle in Santa Cruz Valley, Tucson, Arizona, May 3, 1884.

Specimens examined.—*Arizona:* fifteen miles above Pierces Ferry (M. E. Jones 5077ar); Tucson (J. W. Toumey 748, 798); Bradshaw Mts. (J. W. Toumey 27); near Congress (C. R. Orcutt 2531). *Texas:* El Paso (M. E. Jones 19a).

This may be the *Bromus hookeri schlechtendalii* Fourn. Mex. Pl. **2** : 127. 1886, as it differs only in a few minor particulars from the original description of that variety. It also closely approaches *B. marginatus seminudus.*

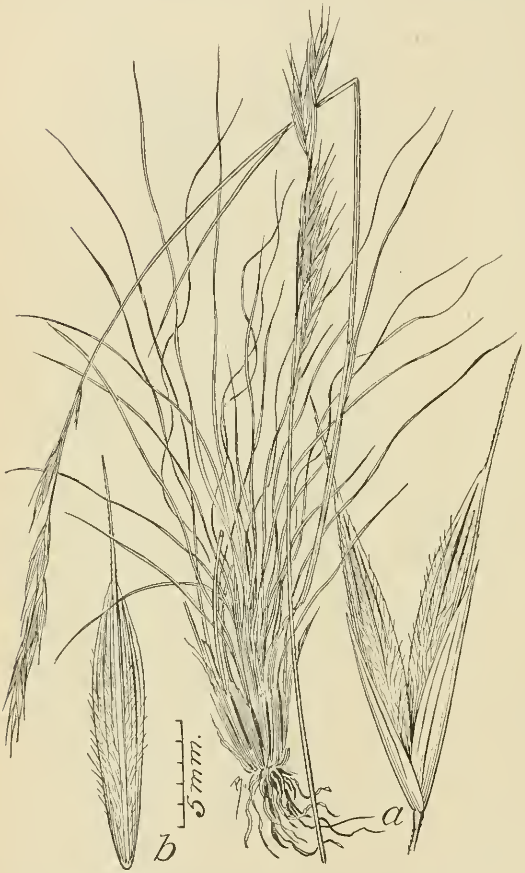

Fig. 39.—*Bromus carinatus linearis: a,* empty glumes with two florets; *b,* dorsal view of a flowering glume.

36. BROMUS LACINIATUS Beal, Grass. N. A. 2 : 615. 1896. (Fig. 40.)

An erect perennial with a lax, somewhat secund panicle and laterally compressed purplish spikelets. Culm about 5–7 dm. high, smooth or slightly pubescent at the nodes. Sheaths *smooth;* ligule about 2 mm. long, subtruncate, laciniate; blades *smooth,* both sides linear-lanceolate, ascending, somewhat stiff, 5–20 cm. long by 3–5 mm. broad. Panicle suberect or somewhat drooping, lax, about 10–17 cm. long, lower rays 3–4, slender, bearing 1–2 spikelets. Spikelets about 5-flowered, *2–2.5 cm. long, about 5 mm. broad,* lower somewhat drooping, laterally compressed; empty glumes *smooth,* lower broad-lanceolate, acute, 3-nerved, 6–7 mm. long, upper broader, obtuse, 5–7-nerved, 8–9 mm. long; flowering glume ovate-lanceolate, *chartaceous, scabrous, 5–7-nerved, 11–13 mm. long,* with two short subacute teeth at the apex, and an awn *5–6 mm. long;* palea about equaling its glume.

Type No. 4897 C. G. Pringle, Pl. Mex. 1894, Sierra de San Felipe, alt. 9500 ft., State of Oaxaca.

The above description is from the specimen of the above number in the National Herbarium. The species has not been reported from the United States, but it may extend this side the Mexican border. It resembles very closely small forms of *B. polyanthus paniculatus*.

SPECIES EXCLUDED.

Bromus giganteus L. Sp. Pl. **1**: 77. 1753.=**Festuca gigantea** Willd.

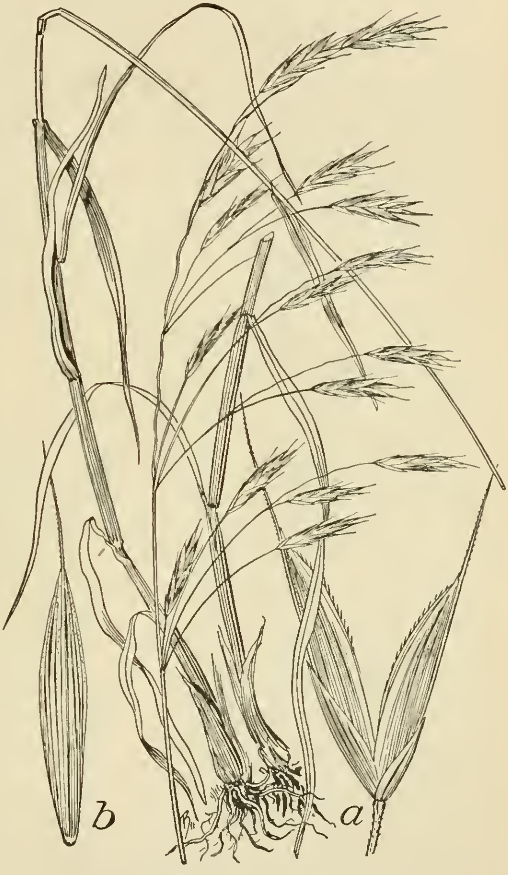

Fig. 40.—*Bromus laciniatus: a*, empty glumes with two florets, *b*, dorsal view of a flowering glume.

Bromus secundus J. S. Presl in C. B. Presl, Reliq. Haenk. **1**: 263. 1830. "Hab in sinu Nootka"=**Festuca rubra secunda** (Presl.) Scribn. Rept. Mo. Bot. Gard. **10**: 39. 1899.

Bromus subulatus Griseb. in Ledeb. Fl. Ros. **4**: 358. 1853.=**Melica subulata** Scribn. Proc. Acad. Nat. Sci. Phil. **1885**: 47. 1885.

SPECIES DOUBTFUL OR UNKNOWN.

Bromus depauperatus, J. S. Presl in C. B. Presl, Reliq. Haenk. **1**: 263. 1830. "Radice repente, culmo glabro, foliis planis vaginisque scabris, panicula secunda nutante simplici laxa patentissima, locustis subtrifloris, paleis inferioribus teretiusculis trinerviis scabris. Hab. in sinu Nootka. ♃." "Similis *Bromo aspero*, Radix repens, firma, crassa, fusca, multas fibras emittens. Culmus sedecim pollices altus inferne crassitie pennæ anatinæ, erectus teres, striatus glaber. Nodi fusci, scabri. Vaginæ elongatæ, arcte adpresse, striatæ, versus collum scabriusculæ. Ligula: margo angustissimus, fimbriolatus. Folia vaginis longiora duas et dimidiam lineam lata, linearia, plana, utrinque scabra. Panicula quinque pollices longa, laxa, secunda, nutans. Rhachis inferne teretiuscula glabra, superne angulata scabra. Rami alternatim binati, flexuosi, angulati, scabri, paucas locustas gerentes. Pedunculi locusta breviores, ramis conformes. Locustæ lanceolatæ, tri-bifloræ, virescenti flavæ. Glumæ locusta triplo breviores, ovato-lanceolatæ, setaceo-terminatæ, glabræ, inferior minor uninervia, superior fere duplo longior trinervia. Flosculi subulati, teretes, distantes. Rhachicula flexuosa, scabriuscula. Palea inferior ovato-lanceolato in apicem acutissimum protracta, apice bidentata dentibus setiformibus, extus scabriuscula, trinervia. Arista paulo brevior, scabra, recta, palea superior paululum brevior, acutissima apice bimucronata, binervia, bicarinata, carinis scabra, pagina exteriore scabriuscula."

Judging from the description of the spikelets and the florets, this is not a true *Bromus*, although Dr. Beal in his Grasses of North America regards it as such, and has referred to it collections by Bolander and Kellogg from San Diego, California.

Bromus segetum H. B. K. Nov. Gen. et Sp. Pl. I. 151. 1815. "B. culmo glabro; foliis vaginisque pilosis; panicula subsimplici, verticillata, secunda, nutante, ramis rhachique hispido-scabris; spiculis lineari-oblongis, subsexfloris; glumis paleisque glabriusculis; arista longitudine paleæ. Crescit in cultis regni Quitensis, prope Lloa, Villa de Ibarra et Chillo, alt. 1340–1500 hexap. ⊙ Floret Januario. Culmi erecti, tri-aut quadripedales, simplices, teretes, striati, glabri. Nodi pilosi. Folia linearia, acuminata, plana, striata, externe piloso-scabra, interne pilosa. Vaginæ striatæ pilosæ. Ligula ovata, obtusa, glabra. Panicula subsimplex, secunda, verticillata, nutans, pedalis, ramis longissimis, nigropurpurascentibus, hispido-scabris, spiculas duas aut tres, rarius unicam ferentibus. Rhachis piloso-scabra. Spiculæ lineari-oblongæ, quinque-aut sexfloræ. Glumæ inæquales, inferior duplo brevior, lanceolato-subulata, apice scabriuscula, superior oblonga, acuminata, subaristata, trinervia, virescens, glabriuscula, spicula triplo brevior. Paleæ lanceolato-oblongæ, glabriusculæ, subæquales, inferior acuminata, subquinquenervia, superior bicarinata, angustior et tenuior, apice bidentata, in carinis ciliato-scabra. Arista subterminalis, recta, scabra, longitudine paleæ. *Bromo arvensi* simillimus."

Bromus setaceus Buckl. Proc. Acad. Nat. Sci. Phil. **14**: 98. 1862. "Culmo erecto 2–3 pedali; vaginis inferioribus glabris, superioribus marginibus et faucibus parce villosis; ligulis 2–3 lin. lon. apice laciniatis; foliis glanis pubescentibus margine ciliatis 4–6 policaribus 3–4 lin. latis; panicula diffusa composita 6–8 policari 4–5 polic. latis; radiis 5–7 nis basi nudis hirsutis ad apicem compositis; ramulis 3–4 nis, unispicatis; spiculis 4–5 floris oblongo obovatis; glumis parum inæqualibus carinatis lineari lanceolatis ciliatis acuminatis, marginibus apicibusque albo-hyalinis, superiore 3–5 nervia; valvula inferiore lanceolata 5–7 nervia ciliata apice bifida et aristata; seta 6 lin. lon. Northern Texas."

"The longest of the lower branches of the panicle 3–4 inches in length and the shorter branches 1–2 inches long, all destitute of spikes excepting near their tops; spikes loosely flowered; internodes on the rachis 1–2 inches long; pedicels 4–6 lines in length; spikes without the bristle about ½ inch long, loosely flowered; upper florets abortive, 2–3 united, appearing to the naked eye like one with 2–3 bristles."

Dr. Gray says in his notes on Buckley's paper published in the volume cited that this is *B. sterilis* L., but the description does not apply closely enough to that species to warrant us in accepting it as a synonym of that. Nuttall's and Buckley's specimens, kindly loaned us by the Philadelphia Academy, did not contain this plant, so it must remain doubtful for the present.

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  rubens Pers 28
  rubra secunda (Presl.) Scribn 63
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Michelaria Dum 9
Schedonorus Beauv 9
  inermis Beauv 47
  sterilis Fr 28
  tectorum Fr 29
Schenodorus Beauv 9
Serrafalcus Parl 9
  arvensis Parl 20
  commutatus Bab 18
  intermedius Parl 19
  mollis Parl 18
  patulus Mert. & Koch 21
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  scoparius Parl 23
  secalinus Bab 16
  squarrosus Bab 21
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Triniusia Steud 9
Trisetum barbatum Steud 23
    major Vas 24
  hirtum Trin 23
Zerna Panz 9, *30*

○

BULLETIN No. 24. Agros. 73.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

STUDIES
ON
AMERICAN GRASSES.

I. SOME RECENT COLLECTIONS OF MEXICAN GRASSES.
By F. LAMSON-SCRIBNER and ELMER D. MERRILL.

II. NOTES ON PANICUM NITIDUM LAM., PANICUM SCOPARIUM LAM., AND PANICUM PUBESCENS LAM.
By F. LAMSON-SCRIBNER and ELMER D. MERRILL.

III. MISCELLANEOUS NOTES AND DESCRIPTIONS OF NEW SPECIES.
By F. LAMSON-SCRIBNER and CARLETON R. BALL.

ISSUED JANUARY 9, 1901.

1862 1889

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

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ISSUED JANUARY 9, 1901.

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WASHINGTON:
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1900.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., October 3, 1900.

SIR: I have the honor to transmit herewith the manuscript of three papers embodying studies in systematic agrostology made in this Division, and I respectfully recommend their publication under the general title of "Studies on American Grasses," in conformity with papers of like character previously published by this Division.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

HON. JAMES WILSON,
Secretary of Agriculture.

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I.—SOME RECENT COLLECTIONS OF MEXICAN GRASSES.

By F. Lamson-Scribner and Elmer D. Merrill.

INTRODUCTION.

In this paper are enumerated 227 species and varieties of Mexican grasses, of which 11 species and 1 variety are described as new. The specimens on which the list is based include the following recent collections from Mexico.

Forty-four specimens collected by Mr. C. L. Smith in 1894, chiefly in the State of Vera Cruz; 100 specimens collected in 1897 by Dr. J. N. Rose in the Sierra Madre Mountains and along the Pacific coast; 122 specimens collected by Dr. E. Palmer in 1896, chiefly on the western coast; 50 specimens collected by Dr. E. Palmer in 1897, chiefly from the State of Durango; 98 specimens collected by Dr. E. Palmer in 1898, chiefly from the State of Coahuila; a collection by Mr. C. G. Pringle in 1896 from the State of Colima, and another in 1899 by the same collector from the State of Vera Cruz; and 40 specimens collected by Mr. E. W. Nelson in 1899 from the State of Chihuahua. In addition to these collections are also included the few species secured by Messrs. Rose and Hough in 1899, a few by Mr. Pringle previous to 1896, and several by Mr. J. G. Smith in 1892.

Since the publishing of Fournier's Mexican Plants in 1881, considerable work has been done on the grass flora of Mexico, but the publications on the subject are widely scattered throughout the periodical literature. The only recent articles dealing entirely with Mexican grasses are "A List of the Grasses Collected by E. Palmer in the Vicinity of Acapulco, Mexico, 1894–95," by F. Lamson-Scribner;[1] "Some Mexican Grasses Collected by E. W. Nelson in Mexico, 1894–95," by F. Lamson-Scribner and Jared G. Smith;[1] and Circular No. 19 of the Division of Agrostology on "New or Little Known Mexican Grasses," which was issued January 2, 1900. In order to make the present paper more complete, the grasses enumerated in Circular No. 19 have been included, each species that was considered in that circular being marked with an asterisk.

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[1] Bul. 4, Division of Agrostology, U. S. Department of Agriculture.

LIST OF SPECIES.

Euchlæna mexicana Schrad. Ind. Sem. Hort. Goett. (1832); Linnæa, **8**: 25 (1833). Sierra Madre Mountains, altitude 1,600 m., State of Durango, 3513 J. N. Rose, August 15, 1897; State of Durango, 743 E. Palmer, September, 1896.

A plant very much resembling corn, found along water ditches at Navocyana Ranch, very valuable for forage, passing under the common name of "Maizillo."

Tripsacum fasciculatum Trin. in Steud. Nom. ed. 2, **2**: 712 (1841).

Durango, State of Durango, 537 E. Palmer, August, 1896; on the road near Huejuquilla, State of Jalisco, 3570 J. N. Rose, August 25, 1897.

TRIPSACUM PILOSUM Scribn. & Merrill, sp. nov. (Fig. 1.)

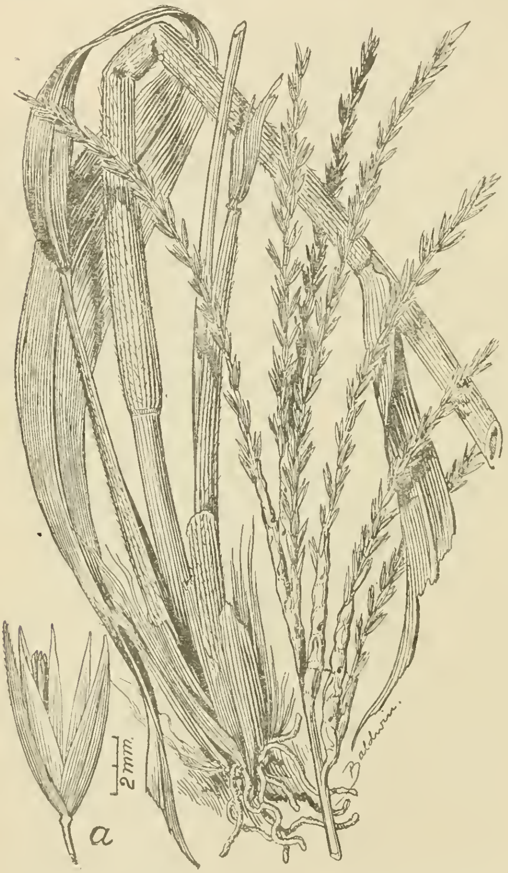

Fig. 1.—*Tripsacum pilosum* Scribn. & Merrill: *a* A staminate spikelet.

A stout, erect perennial about 15 dm. high, with broad, lanceolate, pubescent leaves. Culms about 1 cm. in diameter at the base, smooth below, pilose with rather short white hairs below the panicle; nodes smooth; sheaths longer than the internodes, subcompressed above, scabrous, the lower ones strongly tuberculate-hispid; ligule very short, truncate; leaf blades 4 to 6 dm. long, 2 to 3 cm. wide, acuminate, gradually tapering to the narrow base, strongly strigose-pubescent on both sides or sometimes somewhat pilose beneath, very strongly serrulate-scabrous on the margins. Inflorescence terminal and axillary, fasciculate; branches of the terminal inflorescence about 2 dm. long, erect; the lower pistillate spikelets few, the upper staminate ones numerous, about 8 mm. long, green or purple, the outer glumes faintly 7 to 11 nerved, acute or somewhat obtuse, scabrous on the keel and margins near the apex.

A very distinct species, at once recognized by its broad and rather soft pubescent leaves and hispid sheaths.

Collected on the road between Colotlan and Bolanos, State of Jalisco, 2841 J. N. Rose, September 7, 1897.

***Ischæmum latifolium** Kunth, Rev. Gram. **1**: 168 (1835).

Under the spray of the Cascade in the Barranca of Texola, near Jalapa, altitude 1,100 m., 8106 C. G. Pringle, April 30, 1899.

Trachypogon montufari Nees, Agrost. Bras. 342 (1829).

Las Sedas, altitude 2,000 m., State of Oaxaca, 953 C. L. Smith, September 8, 1894; Durango, State of Durango, 383 E. Palmer, July, 1896.

Elionurus barbiculmis Hack. in DC. Monog. Phan. **6**: 339 (1889).

Durango, State of Durango, 549 E. Palmer, August, 1896; near San Juan Capistrano, State of Zacatecas, 2407 J. N. Rose, August 18, 1897.

Elionurus tripsacoides H. B. K. in Willd. Sp. Pl. **4**: 941 (err. typ. 741) (1805).

Jalapa, State of Vera Cruz, 1623½ C. L. Smith, 1894.

Andropogon contortus L. Sp. Pl. 1045 (1753). (*Heteropogon contortus* R. & S. Syst. **2**: 836 (1817).)

Durango, State of Durango, 540 E. Palmer, August, 1896; Bolanos, State of Jalisco, 2938 J. N. Rose, September 10–19, 1897.

Andropogon liebmanni raripilis Hack. in DC. Monog. Phan. **6**: 413 (1889).

In the Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 2222 J. N. Rose, August 12, 1897.

Andropogon macrourus Michx. Fl. Bor. Am. **1**: 56 (1803).

San Antonio Valley, State of Oaxaca, 970 C. L. Smith, September 1, 1894; Durango, State of Durango, 251 E. Palmer, June, 1896.

Andropogon melanocarpus Ell. Sk. Bot. S. C. and Ga. **1**: 146 (1817) (*Heteropogon melanocarpus* Benth. Journ. Linn. Soc. **19**: 71 (1881).)

In the Sierra Madre Mountains, west of Bolanos, State of Jalisco, 2596 J. N. Rose, September 15–17, 1897.

Andropogon nutans incompletus Hack. in DC. Monog. Phan. **6**: 531 (1889).

Las Sedas, State of Oaxaca, 917 C. L. Smith, September, 1894.

ANDROPOGON PRINGLEI Scribn. & Merrill, sp. nov.

An erect cæspitose perennial 9 to 11 dm. high, with slender culms, short leaves, and slender racemes 3 to 6 cm. long, terminal on the culm or its branches. Culms cylindrical, purplish, very smooth; nodes glabrous; sheaths much shorter than the internodes, glabrous, striate, rather loose, the lowermost compressed, the upper ones somewhat inflated; ligule very short, truncate, ciliate-fringed with short hairs; leaf-blades pale green, those of the innovations linear, 8 to 11 cm. long, 1 to 2 mm. wide, pilose, with long white hairs on the upper surface near the base, smooth beneath, those of the culm rather rigid, linear-lanceolate, acute, 2 to 6 cm. long, 3 to 4 mm. wide, plane or folded, minutely strigose-pubescent at the throat, strongly serrulate-scabrous on the keel and margins near the apex, otherwise smooth. Racemes 3 to 4, subdigitate, rarely solitary, somewhat inclosed by the upper sheath or finally exserted; common rachis 1 to 2 cm. long; axis of the racemes 7 to 11 jointed, subflexuous, pilose with long white hairs, smooth and flattened on one side. Sessile spikelets linear-lanceolate, acute or acuminate, 6 to 8 mm. long, about twice exceeding the joints of the rachis; first glume lanceolate, acute, 2-toothed at the apex, scabrous on the keels above. otherwise glabrous, plane or slightly sulcate; second glume equaling the first, 1-nerved, acute, glabrous except at the scabrous apex; third glume about as long as the second, hyaline, smooth; flowering glume about 4 mm. long, hyaline, smooth, faintly 3-nerved, deeply cleft at the apex, bearing a slender geniculate awn 10 to 14 mm. long, which is twisted below the geniculation, scabrous above. Stamens one, about 1 mm. long. Callus-hairs about 1 mm. long. Pedicellate spikelets much smaller than the sessile ones, reduced to one or two purplish glumes, very narrowly linear-lanceolate, about 5 mm. long, scabrous at the apex; pedicels slender, slightly enlarged above, about three-fourths as long as the sessile spikelet, rather densely silky-bearded with erect or spreading white hairs about 4 mm. long.

Type specimen 6577 C. G. Pringle, Valley of Mexico, Federal District, October 23, 1896.

This species belongs to the subgenus *Arthrolophis* and is related to the group containing *Andropogon liebmanni* Hack., but differs from this and other related species in its swollen upper sheaths, much larger sessile spikelets, stouter and longer less pubescent racemes, which at first sight bear some resemblance to those of *A. provincialis* Lam.

Andropogon saccharoides Swartz, Prodr. Veg. Ind. Occ. 26 (1788).

Saltillo, State of Coahuila, 4 E. Palmer, April, 1898; 810 E. Palmer, September, 1898; near Casas Grandes, State of Chihuahua, 6342 E. W. Nelson, August 30, 1899.

Andropogon saccharoides barbinodis (Lag.) Hack. in DC. Monog. Phan. **6**: 494 (1889). (*Andropogon barbinodes* Lag. Gen. et Sp. 3 (1816).)

Near Plateado, State of Zacatecas, 2758 J. N. Rose, September 3, 1897.

Andropogon saccharoides leucopogon (Nees) Hack. in DC. Monog. Phan. **6**: 496 (1889). (*Andropogon leucopogon* Nees, Linnæa, **19**: 694 (1845).)

Durango, State of Durango, 538 E. Palmer, August, 1896.

Andropogon saccharoides perforatus (Trin.) Hack. in DC. Monog. Phan. **6**: 496 (1889). (*Andropogon perforatus* Trin. in Fourn. Mex. Pl. **2**: 59 (1881).)

Santiago Papasquiaro, State of Durango, 469 E. Palmer, August, 1896.

Andropogon saccharoides torreyanus (Steud.) Hack. in DC. Monog. Phan. **6**: 495 (1889). (*Andropogon torreyanus* Steud. Nom. ed. 2, **1**: 98 (1840).)

Jalapa, State of Vera Cruz, 1623 C. L. Smith, 1894; Durango, State of Durango, 250 E. Palmer, June, 1896.

Andropogon tener Kunth, Rev. Gram. **2**: 565 (1835).

Sienga, State of Durango, 858 E. Palmer, November, 1896.

Anthephora elegans Schreb. Beschr. Gras. **2**: 105. *t. 44* (1772–1779).

Colima, State of Colima, 146 E. Palmer, 1897.

Hilaria cenchroides H. B. K. Nov. Gen. et Sp. Pl. **1**: 117 (1815).

Durango, State of Durango, 379, 540 E. Palmer, July, 1896; Huejuquilla, State of Jalisco, 2542 J. N. Rose, August 25, 1897, growing on the banks of water ditches in alkali bottoms.

Hilaria mutica Benth. Journ. Linn. Soc. **19**: 62 (1881).

Torreon, State of Coahuila, 506 E. Palmer, October, 1898.

Ægopogon geminiflorus H. B. K. Nov. Gen. et Sp. Pl. **4**: 133, *t. 43* (1820).

Sierra de San Felipe, State of Oaxaca, 914, 1816 C. L. Smith, 1894; near Plateado, State of Zacatecas, 2791 J. N. Rose, September 4, 1897; Sierre Madre Mountains, 10 miles north of Pachico, State of Chihuahua, 6294 E. W. Nelson, August 25, 1899.

Nazia aliena (Spreng.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **17**: 28, *fig. 324* (1899). (*Lappago aliena* Spreng. Neue Entd. **3**: 15 (1822).)

Durango, State of Durango, 763 E. Palmer, October, 1896; Saltillo, State of Coahuila, 396 E. Palmer, September, 1898, in cemeteries and waste places.

Arundinella auletica Rupr. Bul. Acad. Brux. **9**: 242 (1842).

Jalapa, State of Vera Cruz, 1892 C. L. Smith, 1894.

* **Paspalum candidum** Kunth, Mém. Mus. Par. **2**: 68 (1803). (See Kew Index.)

Barranca of Texola, near Jalapa, State of Vera Cruz, altitude 1,100 m., 7884 C. G. Pringle, April 30, 1899.

Paspalum conjugatum Berg. Act. Helv. **7**: 129. *t. 8* (1772).

Colima, 16 E. Palmer, July, 1897, in low, wet bottom lands.

Paspalum distichum L. Amoen. Acad. **5**: 391 (1760).

Durango, State of Durango, 192 E. Palmer, June, 1896; Saltillo, State of Coahuila, 259, 391 E. Palmer, 1898. This grass, commonly called "sacate de grama," is found about ponds and water courses, cows and horses being very fond of it. It is used medicinally as a blood purifier, a hot tea being made which is taken internally.

Paspalum inops Vasey, Contr. U. S. Nat. Herb. **1**: 281 (1893).

Near Plateado, State of Zacatecas, 2781 J. N. Rose, September 3, 1897.

PASPALUM NOTATUM Flügge, Monog. 106 (1810).

Las Sedas, altitude 2,000 m., State of Oaxaca, 933 C. L. Smith, September 8, 1894; Colima, 138 E. Palmer, August, 1897.

PASPALUM PANICULATUM L. Syst. Nat. ed. 10, 855 (1758–59).

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 1053 C. L. Smith, March 16, 1895; Rosario, State of Sinaloa, 1545 J. N. Rose, July 7, 1897; Colima, 18 E. Palmer, July, 1897.

Paspalum plicatulum Michx. Fl. Bor. Am. **1**: 45 (1803).

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 1054 C. L. Smith, March 12, 1895; between Rosario and Acaponeta, State of Sinaloa, 1885 J. N. Rose, July 28, 1897; foothills of the Sierra Madre Mountains, near Pedro Paulo, Territorio de Tepic, 1961 J. N. Rose, August 3, 1897; near Acaponeta, Territorio de Tepic, 3294 J. N. Rose, July 30, 1897; Colima, 144 E. Palmer, August, 1897.

PASPALUM PROSTRATUM Scribn. & Merrill, sp. nov. (*Pseudoceresia*).

A low, diffuse, spreading perennial with slender culms, broad rachis, and ovate-lanceolate leaves. Culms, 2 to 3 dm. long, prostrate, finally erect, glabrous, rooting at the lower nodes; nodes glabrous; sheaths loose, compressed, striate, smooth below, sparingly pilose above and on the margins, the lower ones shorter than or about equaling the internodes, the upper one elongated; ligule nearly obsolete; leaf-blades 1.5 to 3.5 cm. long, 5 to 10 mm. wide, rounded or truncate at the base, acute at the apex, pilose beneath and more sparingly so above, serrulate-scabrous on the cartilaginous margins, midnerve somewhat prominent on the lower surface for one-third the length of the leaf, vanishing. Primary axis 6 to 10 cm. long, glabrous; racemes 5 to 10, solitary, remote, alternate, spreading, bearded at the axils, the lower ones 2.5 cm. long, the upper ones shorter; partial rachis 2 to 3 mm. wide, thin, undulate-striate on the back, abruptly acute, smooth or serrulate-scabrous on the margins. Spikelets alternate, imbricate in two rows, short-pedicellate, elliptical-ovate, obtuse, smooth, 2 mm. long; first glume equaling the flowering glume, obtuse, thin, hyaline, 3-nerved, the midnerve faint, the marginal ones more prominent; second glume equaling the flowering glume, more firm in texture, 3 or faintly 5 nerved, slightly sulcate; flowering glume elliptical, obtuse, very smooth. Palea equaling the glume, smooth, plane.

Type specimen 3343 C. G. Pringle, low lands near Patzcuaro, State of Michoacan, November 9, 1890.

This species belongs in the section *Pseudoceresia* and is distinguished from *Paspalum gracile* Rudge by its habit of growth, shorter leaves, solitary racemes, and larger spikelets. Distributed as *Paspalum gracile* Rudge.

PASPALUM PROSTRATUM PYGMÆUM Scribn. & Merrill, var. nov.

A low, densely cæspitose form 3 to 5 cm. high, with loose, pilose sheaths, densely pilose leaves 1 to 2.5 cm. long, 1 to 3 mm. wide, and short inflorescence of 1 to 3 spikes, which are 1 cm. long or less. Rachis and spikelets as in the species.

Type specimen 7167 C. G. Pringle, Pedrigal, altitude 2,600 m. (8,500 feet), Valley of Mexico, Federal District, September 30, 1896. In dry places by the railroad track.

Paspalum pubiflorum Rupr. Bul. Acad. Brux. **9**: 237 (1842).

Durango, State of Durango, 871 E. Palmer, November, 1896; Torreon, State of Coahuila, 515 E. Palmer, October, 1898; near Colotlan, State of Jalisco, 3602 (in part) J. N. Rose, August 28, 1897.

PASPALUM ROSEI Scribn. & Merrill, sp. nov. (Fig. 2.)

A densely cæspitose, simple, erect, glabrous perennial, about 6 dm. high with elongated leaves and long-exserted inflorescence of 2 or 3 slender, divergent spikes. Culms slender, smooth; nodes pilose; sheaths striate, scabrous, short; ligule very short, ciliate-fringed; leaves linear, plane or folded, acute, those of the culm 1 or 2, short; basal leaves numerous, 1 to 3 dm. long, glabrous beneath, more or less pilose with scattered hairs on the upper surface near the base. Inflorescence long-exserted, the branches slender, spreading, 5 to 7 cm. long, undulate, smooth, somewhat pubescent or pilose at the axils. Spikelets 4 mm. long, lanceolate, acute, alternate, very short pedicellate, appressed; first and second glumes equal, lanceolate, acuminate, 5-nerved, sparingly pilose with scattered hairs, especially at the base; flowering glume oblong, obtuse, 3 mm. in length, glabrous, bearing a tuft of few short hairs at the apex. Palea linear-lanceolate, convex, equaling the glume.

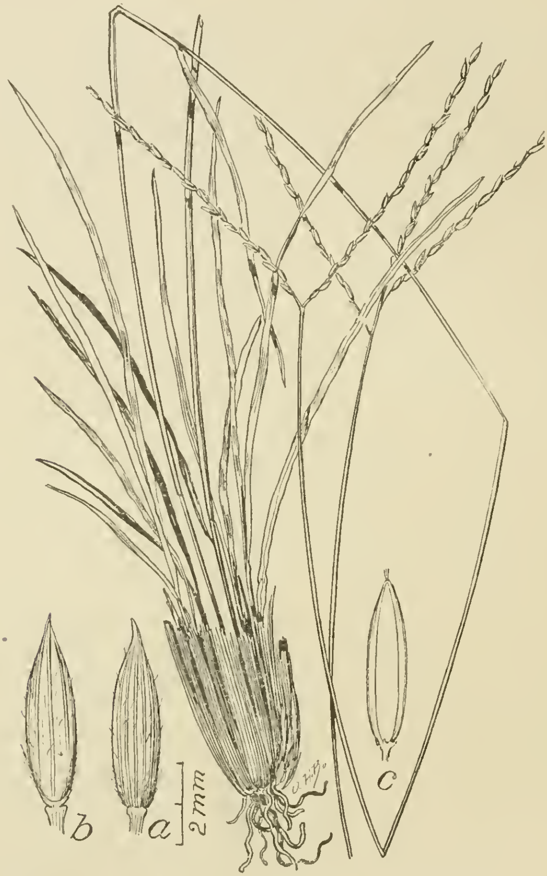

FIG. 2.—*Paspalum rosei* Scribn. & Merrill: *a*, *b*, spikelets; *c*, same with the outer glumes removed.

Foothills of the Sierra Madre Mountains, between Pedro Paulo and San Blascito, 1995 J. N. Rose, August 4, 1897.

Related to *Paspalum neesii* Kunth, but differing in its much smaller spikelets and plane, smooth leaves.

Paspalum squamulatum Fourn. Mex. Pl. 2: 11 (1881).

Jalapa, State of Vera Cruz, C. L. Smith, 1894.

Paspalum tenellum Willd. Enum. Hort. Berol. 89 (1809). (*P. elegans* Flügge, Monog. 183 (1810).)

Lava beds, Pedrigal, Valley of Mexico, Federal District, 6474 C. G. Pringle, September 1, 1896.

Paspalum velutinum (DC.) Kunth, Rev. Gram. **1**: 27 (1835). (*Milium velutinum* DC. Cat. Hort. Monsp. 126 (1813).)

Sandy fields, base of Sierra de Ajusco, altitude 1,900 m., Federal District, 6623 C. G. Pringle, October 29, 1896. This specimen is certainly identical with what Fournier[1] considered to be this species, and there can be little doubt but that it is the same as *Milium velutinum* DC. In habit very much resembling *Panicum sanguinale* L., and intermediate between the section *Digitaria* of the genus *Panicum* and the genus *Paspalum*.

Eriochloa punctata (L.) W. Hamilton, Prodr. Pl. Ind. Occ. 5 (1825). (*Milium punctatum* L. Amoen. Acad. **5**: 392 (1759); *Eriochloa polystachya* H. B. K. Nov. Gen. et Sp. Pl. **1**: 95 (1815).)

Durango, State of Durango, 524, 736 E. Palmer, August and September, 1896; Topolobampo, State of Sinaloa, 242 E. Palmer, September, 1897; Torreon, State of Coahuila, 509 E. Palmer, October, 1898, in rich, moist soil along the Nassus River.

Isachne disperma Doell, in Mart. Fl. Bras. 2^2: 274 (1877).

Jalapa, State of Vera Cruz, 1804 C. L. Smith, 1894.

***Panicum albomaculatum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 2 (January, 1900).

A rather slender, erect, sparingly branched perennial, 6 to 8 dm. high, with striate sheaths, short, ciliate ligules, and spreading panicles 12 to 16 cm. long. Nodes glabrous, the overlapping margins of the sheaths very densely ciliate or subvillous. Leaf-blades 7 to 12 cm. long, 5 to 10 mm. wide (when dry), very acute, rounded at the somewhat clasping base, scabrous on the nerves below, glabrous above, sharply serrulate-scabrous on the narrowly cartilaginous margins, which are ciliate near the base. Axis and branches of the panicle glabrous, the lower longer branches 8 to 10 cm. long. Spikelets ovate, obtuse, 2.5 mm. long; first glume obtuse, 1-nerved, subremote, clasping the pedicel; the second and third glumes 7-nerved, thinly pubescent with short hairs, about equaling the smooth and shining fourth glume; the third glume has a thin, short palea. The exposed

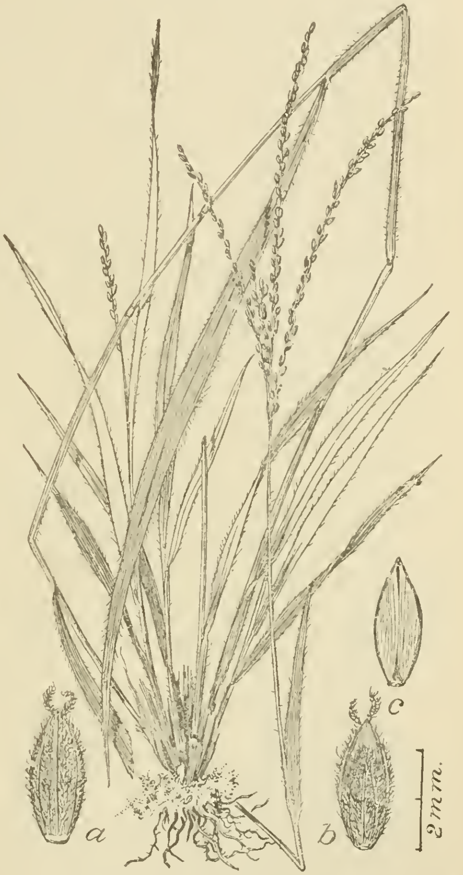

FIG. 3.—*Panicum badium* Scribn & Merrill: *a*, *b*, spikelets enlarged; *c*, same with outer glumes removed.

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[1] Mex. Pl. **2**: 8 (1881).

portion of the culm and sheath purplish, the latter (in the type) white-spotted with small oblong spots or blotches.

Dry, rocky hills, Patzcuaro, State of Michoacan, 5203 C. G. Pringle, October 10, 1892.

Allied to *Panicum scabriusculum* Ell., but readily distinguished by its larger spikelets, less densely flowered panicles, and distinctly cartilaginous, serrulate leaf margins. The plant throughout is more slender.

Panicum avenaceum H. B. K. Nov. Gen. et Sp. Pl. **1**: 99 (1815).

Durango, State of Durango, 741 E. Palmer, August, 1896.

PANICUM (SYNTHERISMA) BADIUM Scribn. & Merrill, sp. nov. (Fig. 3.)

A slender, erect, cæspitose perennial, 4 to 7 dm. high, with linear-lanceolate leaves and digitate panicles of 3 to 5 erect spike-like branches 4 to 7 cm. long. Culms geniculate and compressed below, glabrous or with few long white hairs above; nodes glabrous; sheaths loose, shorter than the internodes, striate, pilose, with rather long spreading hairs; ligule about 2 mm. long, acute or obtuse, hyaline except on the narrow brown margin; leaf-blades 5 to 20 cm. long, 5 to 6 mm. wide, plane, acute, slightly narrowed at the base, pilose on both sides with few, long, white hairs. Inflorescence exserted, the branches slender, glabrous. Spikelets in pairs, one short-pedicellate, one long-pedicellate, ovate, acute, 2.5 mm. long; first glume obsolete; second and third glumes densely pubescent with rather short brown hairs, the former about three-fourths as long as the flowering glume, acute, 3-nerved, the latter equaling the flowering glume, 3 to 5 nerved; flowering glume narrowly ovate, acute or short-acuminate, dark brown, obscurely striate or pitted.

Sierra de San Felipe, State of Oaxaca, altitude between 2,300 and 2,800 m., 915 C. L. Smith, October 6, 1894.

Distributed as *Anthænantia villosa* Beauv. which it somewhat resembles in the pubescence of the outer glumes, but very different in habit and inflorescence. Related to *Panicum phæothrix* Trin. Icon. Gram. **1**: *t. 91* (1828) (*P. ferrugineum* Kunth, Rev. Gram. **1**: 39; **2**: 501, *t. 163* (1835), but readily distinguished by its much broader, pilose leaves, pilose sheaths and culms, and longer second glume.

Panicum bulbosum H. B. K. Nov. Gen. et Sp. Pl. **1**: 99 (1815).

Santiago Papasquiaro, State of Durango, 467 E. Palmer, August, 1896; near Monte Escobedo, State of Jalisco, 2609 J. N. Rose, August 26, 1897; near Dolores, Territorio de Tepic, 2053 J. N. Rose, 1897; between Agnacata and Dolores, 3361 J. N. Rose, August 6, 1897; between Pedro Paulo and San Blascito, Territorio de Tepic, 1999 J. N. Rose, August 4, 1897.

Panicum cæspitosum Swartz, Fl. Ind. Occ. **1**: 146 (1797).

Durango, State of Durango, 433 E. Palmer, August, 1896.

Panicum colonum L. Syst. Nat. ed. 10, 870 (1758–59).

Rosario, State of Sinaloa, 1544 J. N. Rose, July 7, 1897; between Acaponeta and Pedro Paulo, Territorio de Tepic, 1923 J. N. Rose, August 2, 1897; Colima 169 E. Palmer, 1897; Torreon, State of Coahuila, 508 E. Palmer, October, 1898; Parras, 454 E. Palmer, October, 1898; near Colonia Garcia, State of Chihuahua, 6187 E. W. Nelson, August 1, 1899; near Pachico, State of Chihuahua, 6298, 6301 E. W. Nelson, August 26, 1899.

Panicum compactum Swartz, in Griseb. Fl. Brit. W. Ind. 552 (1864).

Near Huasemote, State of Durango, 3502 J. N. Rose, August 15, 1897.

Panicum crus-galli L. Sp. Pl. 56 (1753).

San Francisco, State of Vera Cruz, 1329 C. L. Smith, 1894; Durango, State of Durango, 252, 730 E. Palmer, June–September, 1896; Santiago Papasquiaro, State of Durango, 466 E. Palmer, August, 1896; near Colotlan, State of Jalisco, 3606 J. N. Rose, August 29, 1897; below Pachico, State of Chihuahua, 6244 E. W. Nelson, August 22–24, 1899; between Casas Grandes and Sabinal, State of Chihuahua, 6355a E. W. Nelson, September 4–5, 1899.

Common in low ground about water courses and even in shallow water, reaching to a height of 5 or 6 feet. It is a very prolific species, eagerly eaten by domestic animals. The seeds, which become dark at maturity, are much eaten by birds.

Panicum crus-galli muticum Vasey, Contr. U. S. Nat. Herb. **3**: 37 (1892).

Saltillo, State of Coahuila, 380 E. Palmer, September, 1898.

Panicum fasciculatum Swartz, Prodr. Veg. Ind. Occ. 22 (1788).

Rosario, State of Sinaloa, 1834 J. N. Rose, July 24, 1897.

Panicum fimbriatum (Link) Kunth, Rev. Gram. **1**: 33 (1835). (*Digitaria fimbriata* Link, Hort. Berol. **1**: 226 (1827); *Syntherisma fimbriata* Nash, Bul. Torr. Bot. Club, **25**: 302 (1898).)

Colima, 9 E. Palmer, July, 1897, in a deep, shady ravine; Topolobampo, State of Sinaloa, 234 E. Palmer, September, 1897; Saltillo, State of Coahuila, 387 E. Palmer, September, 1898.

Panicum fuscum Swartz, Prodr. Veg. Ind. Occ. 23 (1788).

Topolobampo, State of Sinaloa, 250 E. Palmer, September, 1897, in an opening on a very stony mountain slope.

Panicum hallii Vasey, Bul. Torr. Bot. Club, **9**: 61 (1884).

Durango, State of Durango, 525 E. Palmer, August, 1896.

Panicum hirticaulum Presl, Rel. Haenk. **1**: 308 (1830).

Between Agnacata and Dolores, Territorio de Tepic, 3351 J. N. Rose, August 6, 1897; near Acaponeta, 1889, 3281 J. N. Rose, July 29, 1897; between Rosario and Acaponeta 1883, 1878 J. N. Rose, July 28, 1897 (the last four numbers are depauperate); Colima, 14, 143, 145 E. Palmer, July, 1897; Topolobampo, State of Sinaloa, 249, 251 E. Palmer, September, 1897; near Pachico, State of Chihuahua, 6297 E. W. Nelson, August 25, 1899; between Casas Grandes and Sabinal, State of Chihuahua, 6355 E. W. Nelson, September 4–5, 1899.

Panicum holciforme Steud. Nom. ed. 2, **2**: 257 (1841).

Durango, State of Durango, 253 *bis* E. Palmer, June, 1896.

***Panicum inflatum** Scribn. & Smith, U. S. Dept. Agr. Div. Agros. Cir. **16**: 5 (1899).

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m., date not given, 7883 C. G. Pringle, 1899.

Panicum insulare (L.) Mey. Prim. Fl. Esseq. 60 (1818).

Durango, State of Durango, 715 E. Palmer, September, 1896.

Panicum lanatum Rottb. Act. Lit. Univ. Hafn. **1**: 269 (1778). (*P. leucophæum* H. B. K. Nov. Gen. et Sp. Pl. **1**: 97 (1815).)

Between Concepcion and Acaponeta, 1900 J. N. Rose, July 29, 1897.

***Panicum laxiflorum** Lam. Encycl. **4**: 748 (1797). (*P. xalapense* Kth.?)

A low, densely cæspitose perennial, 1.5 to 3 dm. high, with crowded, lanceolate, acute, pilose leaves and spreading, ovate panicles 4 to 5 cm. long. Culms much branched near the base, glabrous; nodes bearded with spreading hairs; sheaths pilose with soft, spreading, or reflexed hairs; ligule a dense fringe of hairs about 1 mm. long. Leaves 3 to 6 cm. long, 6 to 10 mm. wide, pilose on both surfaces with soft hairs, ciliate on the margins with long, spreading, papillate hairs. Axis of the panicle glabrous or pubescent. Spikelets oblong, obtuse, 2 mm. long; first glume broadly obtuse, about one-third the length of the spikelet, 3-nerved; the second and third glumes prominently 7-nerved, pubescent, with short, spreading hairs between the nerves.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m., 8083 C. G. Pringle, March 29, 1899; 1752 C. L. Smith, 1894.

Nearly identical with the grass from the Southern States which by recent authors has been referred to *P. laxiflorum* Lam.

Panicum maximum Jacq. Icones Pl. Rar. **1**: *t. 13* (1781–1786).

San Francisco, State of Vera Cruz, 1409 C. L. Smith, 1894.

***Panicum multirameum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 2 (January, 1900).

A rather slender, tufted perennial, 20 to 30 cm. high, with glabrous culms, densely fasciculate-branched above, bearded nodes, and glabrous or thinly pilose sheaths which are bearded at the throat. Lower culm leaves 5 to 8 cm. long, those on the branches much shorter and narrower, sparingly ciliate near the base, pubescent beneath, minutely scabrous along the margins, which are very narrowly cartilaginous. Panicles loosely flowered, 2 to 4 cm. long. Spikelets about 2 mm. long, obtuse, and 7-nerved; the second and third glumes thinly pubescent; the fourth glume subacute; the broadly obtuse first glume one-third to nearly one-half as long as the spikelet.

Gravelly hills near Jalapa, State of Vera Cruz, altitude 1,250 m., 7882 C. G. Pringle, 1899; Orizaba, State of Vera Cruz, 593 J. G. Smith, February 17, 1892.

Allied to *Panicum ciliosum* Nash, but smaller, nodes more distinctly bearded, and leaves less ciliate.

Panicum obtusum H. B. K. Nov. Gen. et Sp. Pl. **1**: 98 (1815).

Torreon, State of Coahuila, 504 E. Palmer, October, 1898; Saltillo, 394 E. Palmer, September, 1898; San Luis Potosi, 1631 E. Palmer, 1898; between Casas Grandes and Sabinal, State of Chihuahua, 6352 E. W. Nelson, September 4–5, 1899. Low places often overflowed. Extensively used as a purgative under the name of "purga de paridas."

***Panicum pilosum macranthum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 1 (January, 1900).

Secondary axes or branches of the panicle (longer lower ones) 3.5 cm. long, pilose with papillate hairs about 2 mm. long. Spikelets 2.2 mm. long, the outer glumes strongly scabrous on the keel near the apex, as are the fruiting glume and palea.

Swamps near Jalapa, State of Vera Cruz, altitude 1,230 m., 8195 C. G. Pringle, May 21, 1899.

Panicum plantagineum Link, Hort. Berol. **1**: 206 (1833).

Near Colotlan, State of Jalisco, 3602 (in part) J. N. Rose, August 28, 1897.

***Panicum polycaulon** Nash, Bul. Torr. Bot. Club, **24**: 200 (1897).

Low places, borders of swamps, Minatitlan, State of Vera Cruz, 555 Jared G. Smith, June 30, 1892.

Panicum repens L. Sp. Pl. ed. 2, 87 (1762–63). (*P. littorale* Vasey, Bot. Gaz. **3**: 106 (1878); *P. gouini* Fourn. Mex. Pl. **2**: 28 (1881).)

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 913 C. L. Smith, March 8, 1895.

Panicum reticulatum Torr. in Marcy's Explor. Red Riv. La. 299 (1852).

Between Rosario and Acaponeta, 1884 J. N. Rose, July 28, 1897.

Panicum sanguinale L. Sp. Pl. 57 (1753).

Colima, 148 E. Palmer, 1897, in a deep, shady ravine; Durango, State of Durango, 766 E. Palmer, October, 1896. Common in fence rows, etc.

Panicum sanguinale ciliare (Retz.) Vasey, U. S. Dept. Agr. Div. Bot. Bul. **8**: 23 (1889). (*Panicum ciliare* Retz. Obs. **4**: 16 (1779–1791).)

Rosario, State of Sinaloa, 1541 J. N. Rose, July 7, 1897.

PANICUM (DIMORPHOSTACHYS) UNISPICATUM Scribn. & Merrill, sp. nov.

A slender, erect perennial, 8 to 15 dm. high, with glabrous culms, sparingly pilose sheaths, lanceolate or linear-lanceolate leaves, and long-exserted solitary spikes 9 to 12 cm. long. Culms very smooth throughout; nodes smooth; sheaths equaling or shorter than the internodes, loose, striate, ciliate on the margins, smooth below, sparingly tuberculate-pilose above; ligule hyaline, membranaceous, lacerate, about 2 mm. long; the throat rather densely bearded, immediately above the ligule, with rigid white hairs about 5 mm. long. Leaf-blades 15 to 30 cm. long, 6 to 12 mm. wide, plane, scarcely narrowed at the abruptly rounded and somewhat clasping base, gradually tapering to a very slender, attenuate and involute, filiform apex, very sparingly tuberculate-pilose on both sides or nearly smooth beneath, ciliate and scabrous on the cartilaginous margins. Inflorescence a pale green, long-exserted, erect or very slightly curved spike, solitary or 2 from the upper sheath, 9 to 12 cm. long, the spikelets in pairs, one sessile and one short-pedicellate, in two rows on one side of the smooth rachis. Spikelets ovate, acute, glabrous, 3 to 4 mm. long; first glume of the sessile spikelet one-third as long as the flowering glume, or shorter, obtuse, hyaline, not increasing in size toward the apex of the spike; that of the pedicellate spikelet lateral or twisted so as to appear in a lateral position, lanceolate, acuminate, about three-fourths as long as the flowering glume, 1-nerved, scabrous at the apex; second glume ovate, acute, glabrous, 3 or faintly 5 nerved, equaling the flowering glume in length; third glume concave, 3-nerved, slightly exceeding the flowering glume, subtending a lanceolate, hyaline, 2-nerved palea as long as the glume; flowering glume ovate, acute, minutely striate or pitted throughout. Palea similar in texture and markings, plane or slightly concave.

Type specimen 6717 C. G. Pringle, Valley of Oaxaca, State of Oaxaca, July 13, 1897.

This species belongs to the group on which Fournier based his genus *Dimorphostachys*,[1] and is related to the South American *Panicum monostachyum*,[2] but is abundantly distinct, differing from the description and plate in Kunth's Rev. Gram. 380, *t. 104*, in its larger size, smooth nodes and culms, broader and not soft pilose leaves, larger spikelets, and much larger first glume of the sessile spikelet; moreover Kunth does not mention or figure a long lateral first glume of the pedicellate spikelet in his description of *P. monostachyum*, which is so prominent in our species.

Distributed as *Paspalum schaffneri* Griseb.

***Panicum viscidellum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 2 (January, 1900).

A slender, ascending or erect, finally branching perennial, 6 to 10 dm. high, with numerous bearded nodes, pubescent internodes, pubescent sheaths, lanceolate, acute, pubescent leaves, and ovate, exserted panicles 5 to 7 cm. long. Leaves 5 to 8 cm. long, 1 to 2 cm. broad, cordate-clasping at the base; ligule pilose. Panicle branches somewhat viscid, the lower ones 2.5 to 3 cm. long. Spikelets 1.8 mm. long, obovate, obtuse, or subacute, the 7-nerved second and third glumes glabrous or with a few scattering hairs.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m., 8089 C. G. Pringle, October, 1899; same locality, 1617 C. L. Smith, 1894; in thickets near Mirador, 323 Liebmann, 1841.

Related to *Panicum scoparium* Lam. (*P. viscidum* Ell.), but stems much more slender, leaves shorter and less rigid, panicles smaller, as are also the spikelets, which are nearly smooth. Fournier, in his enumeration of the grasses of Mexico, refers this grass to *P. commelinæfolium* Rudge,[3] and cites *P. multiflorum* Ell. and *P. microcarpon* "Michx." as synonyms. I have not Rudge's work, "Plantæ Guianæ," in which *P. commelinæfolium* is illustrated, and upon which illustration Fournier based his determination of Liebmann's plant, but our grass is certainly not *P. multiflorum* Ell. (*P. polyanthes* Schultes), nor does it agree with available descriptions of *P. commelinæfolium*. *P. microcarpon* Ell., Sk. Bot. S. C. and Ga. 127, 1817, not Muhl., is the grass now usually referred to *P. barbulatum* Mx.

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[1] Mex. Pl. **2**: 13 (1881).

[2] H. B. K. Nov. Gen. et Sp. Pl. **1**: 96 (1815).

[3] Mex. Pl. 2: 20 (1881).

Panicum velutinosum Nees in Trin. Gram. Panic. 144 (1826).

State of Durango, 2280 J. N. Rose, August 14, 1897; Colima, 149 E. Palmer, August, 1897.

Oplismenus cristatus Presl, Rel. Haenk. **1**: 323 (1830).

Ometepe Island, Nicaragua, 1075 C. L. Smith, 1894.

Chætochloa composita (H. B. K.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39 (1897). (*Setaria composita* H. B. K. Nov. Gen. et Sp. Pl. **1**: 110 (1815).)

Saltillo, State of Coahuila, 378, 449 E. Palmer, September, 1898; on the road from Casas Grandes to Sabinal, State of Chihuahua, 6368 E. W. Nelson, September 4–5, 1899. Along fence rows, etc.

Chætochloa grisebachii (Fourn.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39 (1897). (*Setaria grisebachii* Fourn. Mex. Pl. **2**: 45 (1881).)

Monte Alban, altitude 1,750 to 1,900 m., near Oaxaca, State of Oaxaca, 939 C. L. Smith, October 8, 1894; Saltillo, State of Coahuila, 385 E. Palmer, September, 1898; Sierra Madre Mountains, 10 miles north of Pachico, State of Chihuahua, 6298 E. W. Nelson, August 25, 1899. A weed in gardens.

Chætochloa grisebachii ampla Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 36 (1900).

Durango, State of Durango, 728 E. Palmer, September, 1896.

Chætochloa imberbis (Poir.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39 (1897). (*Panicum imberbe* Poir. in Lam. Encycl. Suppl. **4**: 272 (1816).)

Oaxaca, State of Oaxaca, 935 C. L. Smith, 1894.

Chætochloa imberbis geniculata (Lam.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 12 (1900). (*Panicum geniculatum* Lam. Encycl. **4**: 727 (1797).)

Jalapa, State of Vera Cruz, 1547 C. L. Smith, 1894; Durango, State of Durango, 378, 381, 539 E. Palmer, July, 1896; Federal District, 6419 C. G. Pringle, 1896; Colotlan, State of Jalisco, 3607 J. N. Rose, August 29, 1897; Colima, 17 E. Palmer, 1897, in rich, shady thickets in a fruit garden.

Chætochloa latifolia Scribn. U. S. Dept. Agr. Div. Agros. Bul. **11**: 44 *pl. 3* (1898).

Durango, State of Durango, 879 E. Palmer, November, 1896, growing under bushes in deep ravines.

Chætochloa latifolia breviseta Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 31 (1900).

Santiago Papasquiaro, State of Durango, 470 E. Palmer, August, 1896, growing under bushes in a deep ravine.

Chætochloa liebmanni (Fourn.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 31 (1900). (*Setaria liebmanni* Fourn. Mex. Pl. **2**: 44 (1881).)

Durango, State of Durango, 716 E. Palmer, September, 1896; Rosario, State of Sinaloa, 1840 J. N. Rose, July, 1897; Topolobampo, 233 E. Palmer, September, 1897; Colima, 142 E. Palmer, August, 1897, under bushes on mountain slopes, many plants together.

Chætochloa liebmanni pauciflora (Vasey) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 33 (1900). (*Chamæraphis caudata pauciflora* Vasey in Beal, Grasses N. A. **2**: 158 (1896).)

Near Acaponeta, Territorio de Tepic, 3303 J. N. Rose, July 31, 1897; Colima, 8 E. Palmer, July, 1897, in shady places on embankments.

Chætochloa longipila (Fourn.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 22 (1900). (*Setaria longipila* Fourn. Mex. Pl. **2**: 47 (1881).)

Between Agnacato and Dolores, Territorio de Tepic, 2017 J. N. Rose, August 6, 1897.

Chætochloa macrostachya (H. B. K.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agroś. Bul. **21**: 29 (1900). (*Setaria macrostachya* H. B. K. Nov. Gen. et Sp. Pl. **1**: 110 (1815).)

Durango, State of Durango, 872 E. Palmer, November, 1896.

Chætochloa purpurascens (H. B. K.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 13 (1900). (*Setaria purpurascens* H. B. K. Nov. Gen. et Sp. Pl. **1**: 90 (1815).)

In the Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 3417 J. N. Rose, August 10, 1897; Saltillo, State of Coahuila, 383, 384 E. Palmer, September, 1898.

Setariopsis auriculata (Fourn.) Scribn. Field Col. Mus. Bot. Ser. **2**: 289 (1896). (*Setaria auriculata* Fourn. Mex. Pl. **2**: 43 (1881).)

Bolanos, State of Jalisco, 2899 J. N. Rose, September 10–19, 1897, small form; Colima, 139 E. Palmer, August, 1897, in low places in a graveyard.

Ixophorus unisetus (Presl) Schlecht. Linnæa, **31**: 420 (1861–62). (*Urochloa uniseta* Presl, Rel. Haenk. **1**: 319 (1830).)

Colima, 141 E. Palmer, July 1, 1897, a strong-growing grass found in low places in a graveyard.

Cenchrus echinatus L. Sp. Pl. 1050 (1753).

Durango, State of Durango, 880 E. Palmer, October, 1896; Rosario, State of Sinaloa, 3110 J. N. Rose, June 21, 1897; Colotlan, State of Jalisco, 3603 J. N. Rose, August 29, 1897.

Cenchrus myosuroides H. B. K. Nov. Gen. et Sp. Pl. **1**: 115, *t. 35* (1815).

Durango, State of Durango, 868 E. Palmer, November, 1896; near San Juan Capistrano, State of Zacatecas, 2453 J. N. Rose, August 21, 1897.

Cenchrus tribuloides L. Sp. Pl. 1050 (1753).

Durango, State of Durango, 196 E. Palmer, June, 1896; near Casas Grandes, State of Chihuahua, 6327 E. W. Nelson, August 30, 1899.

Pennisetum longistylum Hochst. Flora, **24**: 1 (1841).

Topolobampo, State of Sinaloa, 231 E. Palmer, September, 1897. One bunch of this grass found near a water ditch and said to have been accidentally introduced from Florida.

Homalocenchrus hexandrus (Swartz) Britton, Trans. N. Y. Acad. Sci. **9**: 14 (1889). (*Leersia hexandra* Swartz, Prodr. Veg. Ind. Occ. 21 (1788).)

Durango, State of Durango, 195 E. Palmer, June, 1896. Wet banks and in shallow water about ponds and lagoons, extending far from the shore by a network of cane-like rootstocks. A very nutritious grass, cattle not only eagerly devouring the short tops, but even keeping their heads under water in order to reach the submerged portions.

Phalaris canariensis L. Sp. Pl. 54 (1753).

Rosario, State of Sinaloa, J. N. Rose, no number, July 26–29, 1897, in a yard.

Savastana mexicana (Rupr.) Beal, Grasses N. A. **2**: 187 (1896). (*Ataxia mexicana* Rupr. Bul. Acad. Brux. **9**: 233 (1842); *Hierochloa mexicana* Benth.)

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 940 C. L. Smith, August 28, 1894.

Aristida bromoides H. B. K. Nov. Gen. et Sp. Pl. **1**: 112 (1815).

Saltillo, State of Coahuila, 388 E. Palmer, September, 1898; between Casas Grandes and Sabinal, State of Chihuahua, 6369 E. W. Nelson, September 4–5, 1899; near Sierra En Media, State of Chihuahua, 6466 E. W. Nelson, September 24–26, 1899.

Aristida dispersa Trin. & Rupr. Agrost. **3**: 109 (1842).

Durango, State of Durango, 535, 767 E. Palmer, September–October, 1896; near Plateado, State of Zacatecas, 2703 J. N. Rose, August 31, 1897; Colotlan, State of Jalisco, 2812 J. N. Rose, September 6, 1897.

Aristida humboldtiana Trin. & Rupr. Agrost. **3**: 119 (1842).

Pedrigal, Valley of Mexico, Federal District, 6544 C. G. Pringle, October 2, 1896; Serrania de Ajusco, Federal District, 6493 C. G. Pringle, September 6, 1896.

Aristida interrupta Cav. Icon. **5**: 43 *t. 471, f. 2*, (1799).

On lava beds, Pedrigal, Valley of Mexico, Federal District, 6579 C. G. Pringle, October 2, 1896.

Aristida longiramea Presl, Rel. Haenk. **1**: 284 (1830).

Las Sedas, State of Oaxaca, 918 (in part) C. L. Smith, September, 1894.

Aristida purpurea Nutt. Trans. Am. Phil. Soc. **5**: 145 (1837).

Saltillo, State of Coahuila, 392 E. Palmer, September, 1898. A very slender form, growing among rocks on hillsides.

Aristida scabra Kunth, Rev. Gram. **1**: 62 (1835).

Santiago Papasquiaro, 472 E. Palmer, August, 1896; about Cuernavaca, State of Morelos, 6496 C. G. Pringle, September 16, 1896; Bolanos, State of Jalisco, 3694 J. N. Rose, September 10–19, 1897; east base of Sierra Madre Mountains, State of Chihuahua, 6496 E. W. Nelson, September 29, 1899.

Aristida schiedeana Trin. & Rupr. Agrost. **3**: 120 (1842).

Near Plateado, State of Zacatecas, 2793 J. N. Rose, September 4, 1897.

Aristida setifolia H. B. K. Nov. Gen. et Sp. Pl. **1**: 122 (1815).

Las Sedas, State of Oaxaca, 931, 918 (in part) C. L. Smith, September, 1894.

Stipa cærulea Presl, Rel. Haenk. **1**: 227 (1830).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 926 C. L. Smith, September 18, 1894.

Stipa linearifolia Fourn. Mex. Pl. **2**: 73 (1881) (?).

Saltillo, State of Coahuila, 3 E. Palmer, April, 1898. Distributed as *S. viridula* Trin., from which it is very distinct, and although not agreeing in all particulars with Fournier's description of *S. linearifolia*, there can be but little doubt as to its identity. Empty glumes equal, acuminate, 7 mm. long; flowering glume 5 mm. long, pilose with long appressed hairs; awn scabrous, 1.5–2 cm. long, twisted and twice geniculate. Leaf-blades strongly involute, 2–3 dm. long.

Stipa trochlearis Nees in Meyen, Reise, **1**: 484 (1843).

Durango, State of Durango, 532 E. Palmer, August, 1896.

Stipa virescens H. B. K. Nov. Gen. et Sp. Pl. **1**: 126 (1815).

Near Plateado, State of Zacatecas, 2750 J. N. Rose, September 2, 1897.

Muhlenbergia acuminata Vasey, Bot. Gaz. **11**: 337 (1886).

Saltillo, State of Coahuila, 379 E. Palmer, September, 1898, in rich, moist soil.

Muhlenbergia affinis Trin. Agrost. **2**: 291 (1841).

Las Sedas, State of Oaxaca, 952 C. L. Smith, September, 1894; on the road between Mesquitec and Monte Escobedo, State of Jalisco, 2614 J. N. Rose, August 26, 1897; Sierra Madre Mountains, west of Bolanos, 2984 J. N. Rose, September 15–17, 1897.

*__Muhlenbergia alamosana__ Vasey, Bot. Gaz. **16**: 146 (1891).

Mossy cliffs, Sierra de Tepixtlan, near Cuernavaca, altitude 2,300 m., 6994 C. G. Pringle, February 8 and March 14, 1899.

Muhlenbergia arizonica Scribn. Bul. Torr. Bot. Club, **15**: 8, *pl. 76* (1888).

Durango, State of Durango, 536, 713 E. Palmer, August, 1896.

Muhlenbergia berlandieri Trin. Agrost. **2**: 299 (1841).

Durango, State of Durango, 729 E. Palmer, September, 1896.

Muhlenbergia calamagrostidea Kunth, Rev. Gram. **1**: 63 (1835).

Durango, State of Durango, 719, 725, 881 E. Palmer, September–October, 1896; near Plateado, State of Zacatecas, 2736 J. N. Rose, September 3, 1897.

Muhlenbergia capillaris Trin. Gram. Unifl. 191 (1824).

Sienga, State of Durango, 859, 960 E. Palmer, November, 1896.

Muhlenbergia debilis Trin. Gram. Unifl. 193 (1824).

Monte Alban, altitude 1,700 m., near Oaxaca, State of Oaxaca, 938 C. L. Smith, October 8, 1894.

MUHLENBERGIA DENSIFLORA Scribn. & Merrill, sp. nov. (Fig. 4.)

An erect, rigid, caespitose perennial, 6 to 9 dm. high, with involute, wiry leaves and dense, contracted panicles 7 to 12 cm. long. Culms cylindrical, glabrous, or slightly scabrous, especially below the panicle, puberulent below the glabrous nodes; sheaths shorter than the internodes, striate, the lower ones glabrous, the upper scabrous; ligule 5 to 10 mm. long, acute, cleft at the apex; leaf-blades glabrous, rigid, 1 to 3 dm. long, 2 to 3 mm. wide. Panicles somewhat exserted, strict, purplish, about 1 cm. in diameter; rachis angular, scabrous; branches 1 to 2 cm. long, appressed, the lower ones generally remote; pedicels about as long as the spikelets, scabropubescent. Spikelets lanceolate, 5 mm. long; empty glumes subequal, 1-nerved, lanceolate, acute or acuminate, 3 to 3.5 mm. long, scabrous on the keel; flowering glume about 5 mm. long, 3-nerved, scabrous on the nerves and keel, bearing a rather stout scabrous awn at the apex, 1 to 3 mm. in length. Palea equaling the flowering glume, lanceolate, acute, or short-apiculate.

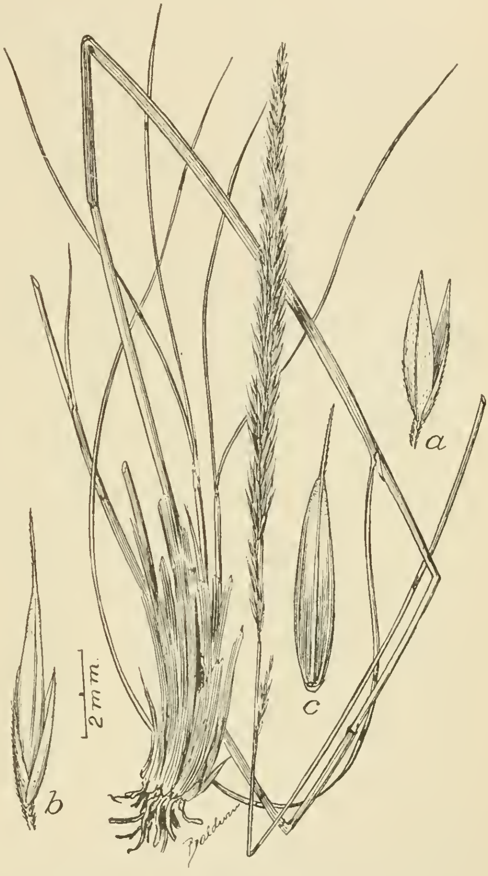

Fig. 4.—*Muhlenbergia densiflora* Scribn. & Merrill: *a*, Empty glume; *b*, spikelet; *c*, flowering glume.

Type collected on lava beds, Serrania de Ajusco, altitude 3,000 m., Federal District, 6675 C. G. Pringle, August 13, 1897; Sierra de San Felipe, altitude 3,000 m., State of Oaxaca, 4914 C. G. Pringle, September 18, 1894; same locality, C. L. Smith, no number, 1894.

Muhlenbergia exilis Fourn. Mex. Pl. **2**: 84 (1881).

San Francisco, State of Vera Cruz, 1506 C. L. Smith, 1894; Sierra Madre Mountains, west of Bolanos, State of Jalisco, J. N. Rose, no number, September 16, 1897.

Muhlenbergia flaviseta Scribn. U. S. Dept. Agr. Div. Agros. Bul. **8**: 11 (1897).

Dos Cajetas, State of Durango, 834 E. Palmer, October, 1896, abundant on the sloping sides of an arroyo.

Muhlenbergia gracilis Trin. Gram. Unifl. 193 (1824).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 928, 937 C. L. Smith, September, 1894.

Muhlenbergia implicata Trin. Gram. Unifl. 193 (1824).

Durango, State of Durango, 718, 769 E. Palmer, September, 1896.

Muhlenbergia laxiflora Scribn. Zoe, **4**: 389 (1894).

Durango, State of Durango, 2356 J. N. Rose, August 16, 1897.

MUHLENBERGIA LIGULATA (Fourn.) Scribn. & Merrill, n. comb. (*Chaboissæa ligulata* Fourn. Mex. Pl. **2**: 112, *t.* — (1881).)

Durango, State of Durango, 731 E. Palmer, September, 1896; 948 E. Palmer, November, 1896, in rich, moist soil in gardens and fields.

The grass here taken to be Fournier's *Chaboissæa ligulata* agrees so closely with the published description and plate of that grass that we have little hesitation in so referring it. The only apparent difference is in the awn of the flowering glume, which in No. 731 E. Palmer is 5 to 6 mm. long. Fournier does not refer to the awn and the illustration shows long-acuminate floral glumes. *Chaboissæa* is placed in the *Poaceæ* by Fournier, but if we have rightly identified Palmer's grass, it certainly belongs to the *Agrostideæ*, and, although the most of the spikelets are 2-flowered, the plant has all the characters of a *Muhlenbergia* and ought to be referred to that genus.

Muhlenbergia monticola Buckl. Proc. Acad. Nat. Sci. Phila. **1862**: 91 (1862).

Durango, State of Durango, 528 E. Palmer, August, 1896.

Muhlenbergia parviglumis Vasey, Contr. U. S. Nat. Herb. **3**: 71 (1892).

Saltillo, State of Coahuila, 417 E. Palmer, September, 1898. Not common; on very dry hillsides.

Muhlenbergia porteri Scribn. in Beal, Grasses N. A. **2**: 259 (1896).

On the road from Casas Grandes to Sabinal, State of Chihuahua, altitude 1,700 m., 6349 E. W. Nelson, September 4–5, 1899.

Muhlenbergia pringlei Scribn. Trans. N. Y. Acad. Sci. **14**: 25 (1894).

Durango, State of Durango, 529, 724 E. Palmer, August, 1896; Saltillo, State of Coahuila, 393 E. Palmer, September, 1898.

***Muhlenbergia setarioides** Fourn. Mex. Pl. **2**: 84 (1886).

Under the spray of the Cascade in Barranca of Texola, near Jalapa, State of Vera Cruz, altitude 1,100 m., 8096 C. G. Pringle, April 30, 1899.

Muhlenbergia setifolia Vasey, Bot. Gaz. **7**: 92 (1882).

Saltillo, State of Coahuila, 415 E. Palmer, September, 1898, on dry slopes, rather rare.

Muhlenbergia texana Thurb. in Coult. Man. Bot. Rocky Mountain Reg. 410 (1885).

Torreon, State of Coahuila, 511 E. Palmer, October, 1898, in bunches of mesquite bushes; a very wiry species.

Muhlenbergia vaseyana Scribn. Rept. Mo. Bot. Gard. **10**: 52 (1899). (*M. distichophylla* Am. authors, not Kunth.)

State of Oaxaca, 916 C. L. Smith, 1894; Sierra de San Felipe, altitude 3,075 m., 927 (in part) C. L. Smith, September 18, 1894; Durango, State of Durango, 542 E. Palmer, August, 1896; Sierra Madre Mountains, west of Bolanos, State of Jalisco, 3003 J. N. Rose, September 15–17, 1897.

Muhlenbergia sp. Allied to *M. gracilis* Trin., but too young for positive identification.

Sierra Madre Mountains, State of Zacatecas, 3527 J. N. Rose, August 17, 1897.

Lycurus phleoides H. B. K. Nov. Gen. et Sp. Pl. **1**: 142 (1815).

Durango, State of Durango, 526 E. Palmer, August, 1896; near Plateado, State of Zacatecas, 2794 J. N. Rose, September 4, 1897; between Casas Grandes and Sabinal, State of Chihuahua, 6356 E. W. Nelson, September 4–5, 1899.

Sporobolus cryptandrus flexuosus Thurb. in U. S. Geog. Surv. W. 100th Merid. **6**: 262 (1878).

Colonia Diaz, State of Chihuahua, 6458 E. W. Nelson, September 20–21, 1899.

Sporobolus domingensis Kunth, Enum. Pl. **1**: 214 (1833).

Sierra de San Felipe, State of Oaxaca, 51 C. L. Smith, 1894; Durango, State of Durango, 384, 737 E. Palmer, July, 1896; Topolobampo, State of Sinaloa, 236 E. Palmer, September, 1897, in open bottom lands.

Sporobolus indicus (L.) R. Br. Prodr. Fl. Nov. Holl. **1**: 170 (1810). (*Agrostis indica* L. Sp. Pl. 63 (1753).)

Jalapa, State of Vera Cruz, 1753 C. L. Smith, 1894; Durango, State of Durango, 193 E. Palmer, June, 1896; near Santa Teresa, Territorio de Tepic, 2142 J. N. Rose, 1897; near Plateado, State of Zacatecas, 2708 J. N. Rose, August 31, 1897.

Sporobolus macrospermus Scribn. in Beal, Grasses N. A. **2**: 302 (1896).

Las Sedas, altitude 2,000 m., State of Oaxaca, 921 C. L. Smith, September 29, 1894.

Sporobolus minutiflorus Link, Hort. Berol. **1**: 88 (1833).

On the road between Mesquitec and Monte Escobedo, State of Jalisco, 2613 J. N. Rose, August 26, 1897.

Sporobolus palmeri Scribn. U. S. Dept. Agr. Div. Agros. Bul. **11**: 48, *pl. 5* (1898).

Durango, State of Durango, 180 E. Palmer, June, 1896, in large bunches in alkali bottoms.

Sporobolus piliferus Kunth, Enum. Pl. **1**: 211 (1833).

Jalapa, State of Vera Cruz, 1569 C. L. Smith, 1894; fields near Jalapa, State of Vera Cruz, altitude 1,250 m., 7881 C. G. Pringle, 1899.

Sporobolus utilis Torr. Pac. R. R. Rept. 5^2: 365 (1857). (*Vilfa saccatilla* Fourn. Mex. Pl. **2**: 101 (1881).)

Durango, State of Durango, 738, 739 E. Palmer, September, 1896.

Sporobolus wrightii Scribn. Bul. Torr. Bot. Club, **9**: 103 (1882).

Durango, State of Durango, 742 E. Palmer, October, 1896; between Rosario and Acaponeta, State of Sinaloa, 1867 J. N. Rose, July 28, 1897; Saltillo, State of Coahuila, 2 E. Palmer, April, 1898; City of Mexico, 4887 Rose and Hough, July 15, 1899; below Pachico, State of Chihuahua, 6243 E. W. Nelson, August 22–24, 1899; near Casas Grandes, State of Chihuahua; 6344 E. W. Nelson, August 30, 1899.

Blepharoneuron tricholepis (Torr.) Nash, Bul. Torr. Bot. Club, **25**: 88 (1898). (*Vilfa tricholepis* Torr. Pac. R. R. Rept. 4^5: 155 (1857).)

Dos Cajetas, State of Durango, 833 E. Palmer, October, 1896; Serrania de Ajusco, Federal District, altitude 4,000 m., 6485 C. G. Pringle, 1896.

Epicampes bourgæi mutica Fourn. Mex. Pl. **2**: 88 (1881).

In the Sierra Madre Mountains, west of Bolanos, State of Jalisco, 3002 J. N. Rose, September 15–17, 1899.

Epicampes pubescens (H. B. K.) Presl, Rel. Haenk. **1**: 235 (1830). (*Agrostis pubescens* H. B. K. Nov. Gen. et Sp. Pl. **1**: 136 (1815).)

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 927 (in part) C. L. Smith, September 18, 1894. Distributed as *Muhlenbergia distichophylla* Kunth. This species is also represented in the National Herbarium by 5576 C. G. Pringle, 1894, from the same locality.

Epicampes robusta Fourn. Mex. Pl. **2**: 89 (1881).

In the Sierra Madre Mountains, west of Bolanos, State of Jalisco, 2997 J. N. Rose, September 15–17, 1897.

Polypogon elongatus H. B. K. Nov. Gen. et Sp. Pl. **1**: 134 (1815).

Nombre de Dios, State of Durango, 111 E. Palmer, April, 1896; Saltillo, State of Coahuila, 2 E. Palmer, April, 1898; Durango, State of Durango, 162 E. Palmer, June, 1897.

Cinna poæformis (H. B. K.) Scribn. & Merrill, n. comb. (*Deyeuxia poæformis* H. B. K. Nov. Gen. et Sp. Pl. **1**: 146 (1815); *Cinnastrum poæforme* Fourn. Mex. Pl. **2**: 91 (1881).)

Sierra de San Felipe, State of Oaxaca, 936 C. L. Smith, August 28, 1894.

Agrostis elata Trin. Agrost. **2**: 364 (1845).

Near Colonia Garcia, in the Sierra Madre Mountains, State of Chihuahua, 6195 E. W. Nelson, August 1, 1899.

AGROSTIS ROSEI Scribn. & Merrill, sp. nov. (Fig. 5.)

A slender, erect perennial, 4 to 5 dm. high, with short, flat leaves and very open, capillary panicles, 1 to 1.5 dm. long. Culms glabrous, somewhat geniculate at the lower nodes; sheaths shorter than the internodes, smooth, striate; ligule hyaline, obtuse, 2 mm. long; leaf-blades linear, acuminate, 5 to 8 cm. long, 2 to 3 mm. wide, scabrous on both sides and on the margins. Panicle very open, pale or purplish, the branches capillary, the lower ones verticillate, the upper ones opposite, spreading, dichotomously or verticillately branching, somewhat scabrous, the lower ones 5 to 6 cm. long; pedicels elongated, flexuous. Spikelets about 2 mm. long; empty glumes ovate-lanceolate, acute, subequal, thin, slightly scabrous on the keel above; flowering glume slightly shorter than the empty glumes, obtuse, often with 2 or 3 blunt teeth at the apex; awn attached near the base, equaling or slightly exceeding the glume, finely scabrous, straight or slightly bent near the middle. Palea very thin, hyaline, lanceolate, obtuse, nearly three-fourths as long as the flowering glume. Grain lanceolate, about 1.5 mm. long.

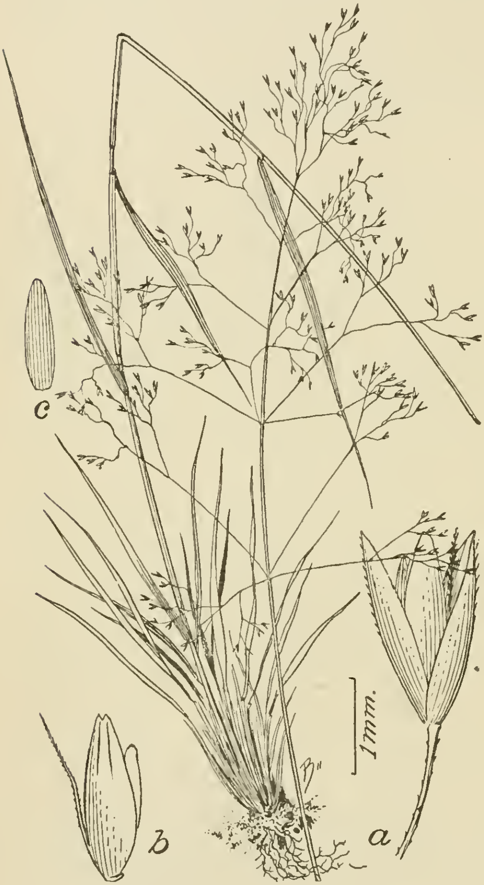

Fig. 5.—*Agrostis rosei* Scrib. & Merrill: *a*, a spikelet; *b*, the awned flowering glume and palea; *c*, the grain.

Type specimen collected on Sierra Madre Mountains, State of Zacatecas, 2373 J. N. Rose, August 18, 1897.

Agrostis setifolia Fourn. Mex. Pl. **2**: 97 (1881).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 922 C. L. Smith, September 25, 1894.

Agrostis verticillata Vill. Prosp. 16 (1779).

Durango, State of Durango, 179 E. Palmer, June, 1896; Nombre de Dios, 95 E. Palmer, April, 1896; Saltillo, State of Coahuila, 806 E. Palmer, September, 1898, in low, wet places along ditches.

Agrostis virletii Fourn. Mex. Pl. **2**: 96 (1881).

Durango, State of Durango, 190 E. Palmer, June, 1896, very abundant in low, wet places in alkali bottoms.

***Avena micrantha** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 3, *fig. 1* (January 1, 1900). (Fig. 6.)

A very slender, densely caespitose, upright perennial, 2.5 to 3.5 dm. high, with soft leaves 6 to 15 cm. long, 1 to 2 mm. wide, ligules 5 to 6 mm. long, and loosely flowered simple panicles 5 to 7 cm. long. Sheaths glabrous; leaves pubescent above, smooth beneath, becoming involute when dry; branches of the panicle capillary, spreading or ascending, 1 to 3 flowered, the longer lower branches 1 to 3 cm. long; empty glumes unequal, lanceolate, the first about 8 mm. long, 1-nerved, the second about as long as the flowering glume, 3-nerved near the base, thin-membranous and abruptly pointed; flowering glumes glabrous, 5-nerved, rounded on the back, 2-toothed at the apex, the teeth awn-like; callus rather densely bearded, hairs stiff, the longer ones 3 to 4 mm. long; awn arising below the apex of the flowering glume, slender, geniculate, twisted below the geniculation, about 17 mm. long. Palea as long as the flowering glume, rather rigid, margins rounded, inflexed, apex subhyaline, the two nerves extending into subulate, awn-like teeth.

Cool, mossy cliffs, Sierra de Tepixtlan, near Cuernavaca, State of Morelos, altitude 2,300 m., 8018 C. G. Pringle, February 5, 1899.

***Avena stipoides** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19:** 4 (January, 1900).

A very slender, erect, somewhat wiry perennial, 5 to 6 dm. high, with linear, erect leaves and loosely few-flowered, simple panicles 5 to 10 cm. long. Sheaths shorter than the internodes, very minutely strigose-pubescent; ligule 5 to 8 mm. long, hyaline; leaves involute-setaceous, at least when dry, 1 to 2.5 mm. wide, 1 to 2 dm. long, scabrous. Spikelets about 12 mm. long, exclusive of the awn; empty glumes unequal, thin, scarious, 1-nerved, acute, the first about 4 mm. long, the second 5.5 mm. long; flowering glume 11 mm. long, 5-nerved, slightly roughened on the nerves above, 2-toothed at the apex, teeth awn-like, awned on the back below the 2-toothed apex; awn geniculate, twisted below, attached about two-thirds above the base, 12 to 14 mm. long. Palea equaling the glume, the two nerves extending into subulate, awn-like teeth. Callus hairs 1 to 2 mm. long.

Sierra de San Felipe, State of Oaxaca, altitude 3,130 m., 4905 C. G. Pringle, September 19, 1894; 923 C. L. Smith, August 28, 1894. Distributed as *Muhlenbergia stipoides* Trin.

This grass is closely allied to *Avena micrantha*, 8018 C. G. Pringle, but is at once distinguished by its shorter empty glumes.

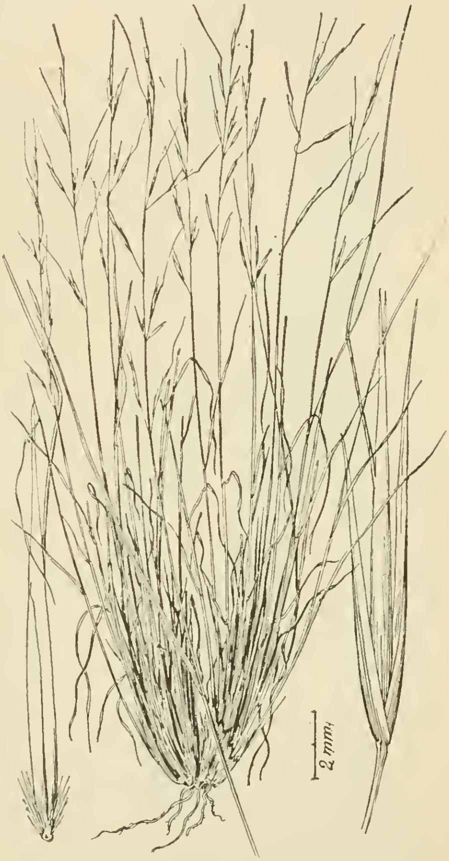

Fig. 6.—*Avena micrantha* Scribn.

The strictly 1-flowered spikelets of this and the last species is a character which would lead one to place these grasses in the tribe *Agrostideæ;* but the densely hairy callus and rather rigid 5-nerved flowering glume, which is deeply 2-toothed at the apex, and the dorsal, geniculate, and twisted awn formed by the union of three of the nerves suggest relationship with *Avena*, as does the character of the empty glumes, and these species are tentatively placed in that genus.

TRISTACHYA AVENACEA (Presl) Scribn. & Merrill, n. comb. (*Monopogon avenaceus* Presl, Rel. Haenk. **1:** 335, *t. 44* (1830); *Tristachya mexicana* Kunth, Enum. Pl. **1:** 308 (1833).)

This plant has been referred to the South American *Tristachya leiostachya* Nees, from which it is readily distinguished by its more slender habit, plane, not involute leaves, and shorter spikelets and awns. The spikelets of *T. leiostachya* are 5 cm. long and the awns are about 12 cm. long. In *T. avenacea* the spikelets are from 2 to 3.5 cm. long and the awns do not exceed 6 cm. in length.

Near Santa Teresa, Sierra Madre Mountains, Territorio de Tepic, 2229 J. N. Rose, August 13, 1897.

TRISTACHYA LAXA Scribn. & Merrill, sp. nov. (Fig. 7.)

A stout, erect perennial, 15 to 20 dm. high, with long leaves, scabrous spikelets, and very lax panicles 4 to 5 dm. in length. Culms rigid, glabrous, about 1 cm. in diameter at the base; nodes smooth; sheaths striate, the lower ones numerous, imbricate, sparingly pubescent, the upper scabrous; ligule a dense ciliate fringe of soft hairs about 2 mm. long; leaf-blades involute or folded below, plane above, 4 to 7 dm. long, 5 to 10 mm. wide, glabrous beneath, scabrous on the upper surface and margins, somewhat bearded at the throat. Panicle very lax, the lower portion somewhat inclosed by the upper sheath; rachis smooth; branches alternate, the lower ones in clusters of twos at each node, solitary above, somewhat pubescent at the axils, very slender, the lower ones 2 dm. long, simple or once branched above the middle. Spikelets short-pedicellate, in clusters of threes at the end of the branches, 1.5 to 2 cm. long; empty glumes purple, 3-nerved, acute, the first slightly shorter than the second, strongly scabrous on the keel and lateral nerves, slightly scabrous on the margins; third glume nearly equaling and inclosed by the first glume, 5-nerved, subtending a hyaline palea nearly its own length and a staminate flower, flowering glume 8 to 9 mm. long, 9-nerved, pubescent throughout with spreading white hairs, apex cleft, forming 2 acute teeth about 2 mm. long and bearing between them a scabrous, geniculate awn 2 to 2.5 cm. in length, which is twisted below the geniculation, straight above.

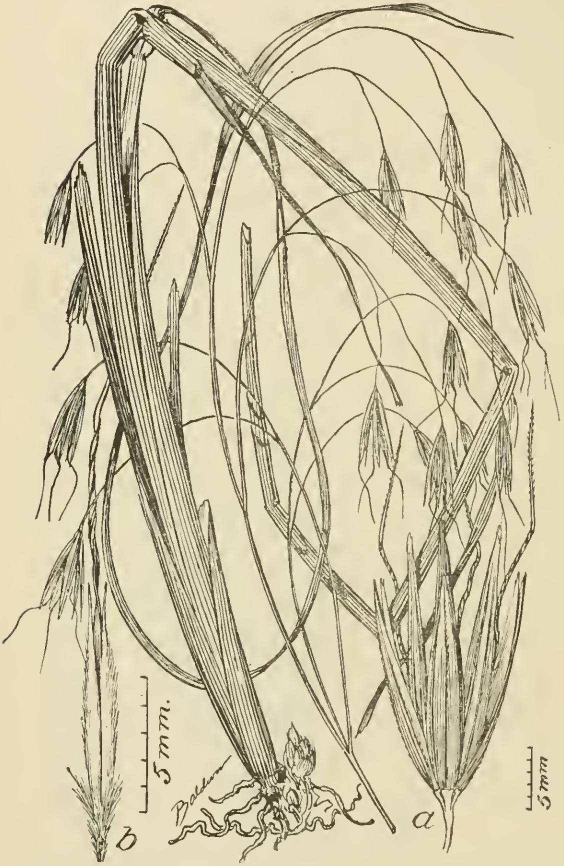

FIG. 7.—*Tristachya laxa* Scribn. & Merrill: *a*, a group of spikelets; *b*, a single floret.

Type collected in the State of Durango, 2334 J. N. Rose, August 16, 1897. Readily distinguished from the other species in this genus by its stout culms, lax panicles, long capillary branches, scabrous empty glumes, and long sterile palea.

Microchloa indica (L. f.) Kuntze, Rev. Gen. Pl. 3^2: 356 (1898). (*Nardus indica* L. f. Suppl. Pl. 105 (1781); *Microchloa setacea* R. Br. Prodr. Fl. Nov. Holl. **1**: 208 (1810).)

Durango, State of Durango, 532 E. Palmer, August, 1896.

Cynodon dactylon Pers. Syn. Pl. **1**: 85 (1805).

Saltillo, State of Coahuila, 254 E. Palmer, June, 1898; 814 E. Palmer, October, 1898.

CHLORIS CLANDESTINA Scribn. & Merrill, nom. nov. (*Gymnopogon longifolius* Fourn. Mex. Pl. **2**: 144 (1881); *Chloris longifolia* Vasey, Contr. U. S. Nat Herb. **1**: 284, *pl. 19* (1893), not Steud. Syn. Pl. Gram. 205 (1854).)

Topolobampo, State of Sinaloa, 238 E. Palmer, September, 1897, in small bunches under other plants in bottom lands.

Chloris elegans H. B. K. Nov. Gen. et Sp. Pl. **1**: 166 (1815).

Durango, State of Durango, 176 E. Palmer, June, 1896; 765 E. Palmer, October, 1896; near Colotlan, State of Jalisco, 3604 J. N. Rose, August 29, 1897; Colima, 140 E. Palmer, September, 1897; Topolobampo, State of Sinaloa, 245 E. Palmer, September, 1897; Parras, State of Coahuila, 448 E. Palmer, October, 1898; on the road from Casas Grandes to Sabinal, State of Chihuahua, 6354 E. W. Nelson, September 4–5, 1899, in open bottom lands, among cacti and other plants.

Chloris submutica H. B. K. Nov. Gen. et Sp. Pl. **1**: 167, *t. 50* (1815).

Durango, State of Durango, 181 E. Palmer, June, 1896; in the Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 2143 J. N. Rose, August 9, 1897; Saltillo, State of Coahuila, 390 E. Palmer, September, 1898.

Bouteloua aristidoides (H. B. K.) Griseb. Fl. Brit. W. Ind. 537 (1864). (*Dinebra aristidoides* H. B. K. Nov. Gen. et Sp. Pl. **1**: 171 (1815).)

Durango, State of Durango, 717 E. Palmer, September, 1896; near San Juan Capistrano, State of Zacatecas, 2490 J. N. Rose, August 23, 1897; Topolobampo, State of Sinaloa, 237 E. Palmer, September, 1897; Torreon, State of Coahuila; 513 E. Palmer, October, 1898; near Casas Grandes, State of Chihuahua, 6329 E. W. Nelson, August 30, 1899.

Bouteloua bromoides (H. B. K.) Lag. Gen. et Sp. Nov. 5 (1816). (*Dinebra bromoides* H. B. K. Nov. Gen. et Sp. Pl. **1**: 172. *t. 51* (1815).)

Between Monte Escobedo and Colotlan, State of Jalisco, 2672 J. N. Rose, August 28, 1897; near Pachico, State of Chihuahua, 6258 E. W. Nelson, August 22–24, 1899; Sierra Madre Mountains. 10 miles north of Pachico, 6305 E. W. Nelson, August 25, 1899.

Bouteloua curtipendula (Michx.) Torr. in Emory, Notes Mil. Recon. 153 (1848). (*Chloris curtipendula* Michx. Fl. Bor. Am. **1**: 59 (1803); *B. racemosa* Lag. Varied. Cienc. Lit. Art. 2^4: 14 (1805).)

Monte Alban, near Oaxaca, State of Oaxaca, 958 C. L. Smith, September 5, 1894; Bolanos, State of Jalisco, 2929 J. N. Rose, September 10–19, 1897; Durango, State of Durango, 194 E. Palmer, June, 1896; Saltillo, State of Coahuila, 407 E. Palmer, September, 1898; below Pachico, State of Chihuahua, 6247 E. W. Nelson, August 22–24, 1899.

Bouteloua havardi Vasey, Proc. Am. Acad. **18**: 179 (1883).

Durango, State of Durango, 546 E. Palmer, August, 1896; near Huejuquilla, State of Jalisco, 2532 J. N. Rose, August 24, 1897; near Plateado, State of Zacatecas, 2782 J. N. Rose, September 3, 1897.

Bouteloua hirsuta Lag. Varied. Cienc. Lit. Art. 2^4: 141 (1805).

Durango, State of Durango, 870 E. Palmer, November, 1896; between Concepcion and Acaponeta, 1904 J. N. Rose, July 29, 1897; near Acaponeta, Territorio de Tepic, 3293 J. N. Rose, July 30, 1897; on the road between Huejuquilla and Mesquitec, State of Jalisco, 2586 J. N. Rose, August 25, 1897; Saltillo, State of Coahuila, 405 E. Palmer, September, 1898; near Pachico, State of Chihuahua, 6246 E. W. Nelson, August 22–24, 1899.

Bouteloua oligostachya Torr. in A. Gray, Man. Bot. ed. 2, 553 (1856).

Durango, State of Durango, 545 E. Palmer, August, 1896; Saltillo, State of Coahuila, 399, 403, 406 E. Palmer, September, 1898; near Casas Grandes, State of Chihuahua, 6327 E. W. Nelson, August 30, 1899.

Bouteloua polystachya Torr. Pac. R. R. Rept. **5**^{2}: 366, *t. 10* (1847).

San Antonio Valley, State of Oaxaca, 957 C. L. Smith, September 1, 1894; Durango, State of Durango, 714 E. Palmer, September, 1896; Torreon, State of Coahuila, 514 E. Palmer, October, 1898; Saltillo, 401 E. Palmer, September, 1898.

Bouteloua ramosa Scribn. in Vasey, U. S. Dept. Agr. Div. Bot. Bul. **12**^{1}: 44, *pl. 44* (1891).

Saltillo, State of Coahuila, 404 E. Palmer, September, 1898, in close tufts in low places on the mesa.

BOUTELOUA REPENS (H. B. K.) Scribn. & Merrill, n. comb. (*Dinebra repens* H. B. K. Nov. Gen. et Sp. Pl. **1**: 172, *t. 52* (1815).)

Durango, State of Durango, 547 E. Palmer, August, 1896.

Bouteloua tenuis Griseb. in Goett. Abh. **24**: 303 (1879).

Durango, State of Durango, 712 E. Palmer, September, 1896; Saltillo, State of Coahuila, 397, 378 E. Palmer, September, 1898; Pedrigal, Valley of Mexico, Federal District, 6450 C. G. Pringle, August 20, 1896. This grass grows so abundantly on the mesquite plains that it gives them the appearance of a lawn.

Bouteloua trifida Thurb. Proc. Am. Acad. **18**: 177 (1883).

Saltillo, State of Coahuila, 402 E. Palmer, September, 1898.

Pentarrhaphis fournierana Hack. & Scribn. Bul. Torr. Bot. Club, **17**: 232, *pl. 107* (1890).

Durango, State of Durango, 382 E. Palmer, July, 1896; between Acaponeta and Rosario, J. N. Rose, no number, July 6, 1897; between Rosario and Colomas, State of Sinaloa, 1621 J. N. Rose, July 12, 1897; near Tequila, State of Jalisco, 4775 Rose and Hough, July 5–6, 1899.

Eleusine indica Gaertn. Fruct. et Sem. **1**: 8 (1788).

Coatzacoalcos, isthmus of Tehuantepec, State of Vera Cruz, 1050 C. L. Smith, March 16, 1895.

Dactyloctenium ægyptium (L.) Willd. Enum. 1029 (1809). (*Cynosurus ægyptius* L. Sp. Pl. 72 (1753).)

Durango, State of Durango, 735 E. Palmer, September, 1896; between Rosario and Acaponeta, State of Sinaloa, 1877 J. N. Rose, July 25, 1897; Coatzacoalcos, isthmus of Tehuantepec, State of Vera Cruz, 1055 C. L. Smith, February 1, 1895; Colima, 10, 11, 167, 168 E. Palmer, July, 1897; Topolobampo, State of Sinaloa, 246 E. Palmer, September, 1897.

LEPTOCHLOA AQUATICA Scribn. & Merrill, sp. nov.

An erect, glabrous, branching perennial about 7 dm. high, with smooth culms, flat leaves, and obtuse flowering glumes. Culms much branched below, striate, cylindrical, rooting at the lower nodes; nodes brown, smooth; sheaths loose, longer than the internodes, the lower ones compressed, smooth or minutely roughened; ligule 1 to 2 mm. long, fimbriate; leaf-blades thin, linear-lanceolate, 10 to 20 cm. long, 5 to 8 mm. wide, slightly scabrous or nearly smooth on both sides, scabrous on the margins. Panicles 10 to 12 cm. long, green; common axis smooth or slightly roughened above, striate; branches erect, 2 to 5 cm. long, alternate, scabrous, floriferous throughout. Spikelets ovate-lanceolate, rather loosely 3 to 4 flowered, about 5 mm. long, on short scabrous pedicels about 1 mm. in length; empty glumes very unequal, 1-nerved, slightly scabrous on the keels, the first about 1 mm. long, narrowly triangular-lanceolate, acute, the second 2 mm. long, broad, rhomboidal, triangular-acute at the apex; flowering glumes about 3 mm. long, broadly ovate (when spread), obtuse, awnless, glabrous except on the scabrous keel, 3-nerved, the middle nerve prominent, percurrent, the lateral ones marginal, extending about two-thirds the length of the glume, slightly pilose. Palea equaling the glumes, lanceolate-spatulate, truncate, and slightly denticulate at the apex, sparingly pilose on the margins below.

Type specimen collected in shallow water near Cuernavaca, State of Morelos, altitude 1,700 m., 6664 C. G. Pringle, August 22, 1897.

In habit very much resembling *Leptochloa halei*, but at once distinguished from that species by its more unequal empty glumes and obtuse awnless flowering glumes.

Leptochloa dubia Nees, Syllog. Ratisb. **1**: 4 (1824).

Santiago Papasquiaro, State of Durango, 468 E. Palmer, August, 1896; Durango, 530 E. Palmer, August, 1896; Saltillo, State of Coahuila, 381, 382 E. Palmer, September, 1898.

LEPTOCHLOA DUBIA PRINGLEANA (Kuntze) Scribn. & Merrill, n. comb. (*Diplachne dubia pringleana* Kuntze, Rev. Gen. Pl. **3**: 349 (1898).)

Hills and plains near Chihuahua, 422 C. G. Pringle, August, 1885.

Leptochloa fascicularis (Lam.) A. Gray, Man. Bot. ed. 5, 623 (1867).

Durango, State of Durango, 254 E. Palmer, June, 1896; Torreon, State of Coahuila, 503 E. Palmer, October, 1898, rich, moist ground, along ditches subject to overflow.

Leptochloa filiformis Presl, Rel. Haenk. **1**: 288 (1830).

Topolobampo, State of Sinaloa, 248 E. Palmer, September, 1897, common on bottom lands.

LEPTOCHLOA HALEI (Nash) Scribn. & Merrill, n. comb. (*Diplachne halei* Nash, Bul. N. Y. Bot. Gard. **1**: 292 (1899).

Foothills between Acaponeta and Pedro Paulo, Territorio de Tepic, 1930 J. N. Rose, August 2, 1897.

This species can scarcely be distinct from *Leptochloa floribunda*, Doell,[1] although the details as drawn in the plate representing that species do not agree with our specimens of *Leptochloa halei* nor with those of authentic material of *Leptochloa floribunda*. There is in the U. S. National Herbarium one sheet of Hale's Louisiana collection and two sheets from the Herbarium Hookerianum, the latter labelled "*Leptochloa floribunda* Doell. Ad ripas fluminis Amazonum inter Santarem et Barra de Rio Negro, Coll. R. Spruce, October, 1850," and also in what is evidently Bentham's handwriting "Texas, Drummond, No. 322 ex herb. T. C. D(rummond) is identical with this." No. 322 Drummond is cited by Nash as the type of *Diplachne halei*.

Doell cited as the type of his species "ad ripas fluminis Amazonum inter Manos et Santarem (Spruce)," and although the material in the National Herbarium may not be of the collection on which *Leptochloa floribunda* is based, there can be no doubt but that it is typical.

A careful comparison of the specimens collected by Hale in Louisiana and those collected by Spruce in Brazil proves conclusively that they are the same, and the only hesitation we have in not referring *Diplachne halei* to *Leptochloa floribunda* is the fact that details of the latter as drawn by Doell differ somewhat from both our North and South American material.

Leptochloa mucronata Kunth, Rev. Gram. **1**: 91 (1835).

Rosario, State of Sinaloa, 1542 J. N. Rose, July 7, 1897; San Jose de Guaymas, 270 E. Palmer, October 14, 1897; Colima, 22 E. Palmer, July, 1897.

Pappophorum apertum Munro, Bul. Torr. Bot. Club, **9**: 148 (1882).

Saltillo, State of Coahuila, 256 E. Palmer, June, 1898; 377 E. Palmer, September, 1898.

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[1] Mart. Fl. Bras. **3**^{2}: 89, *pl. 26* (1878).

Pappophorum wrightii Wats. Proc. Am. Acad. **18:** 178 (1882–83).

Durango, State of Durango, 721 E. Palmer, September, 1896; Saltillo, State of Coahuila, 395 E. Palmer, September, 1898.

Cottea pappophoroides Kunth, Rev. Gram. **1:** 84, 281, *t. 52* (1835).

Bolanos, State of Jalisco, 2914 J. N. Rose, September 10–19, 1897.

Cathestecum prostratum Presl, Rel. Haenk. **1:** 295, *t. 42* (1830).

San Antonio Valley, State of Oaxaca, 958 C. L. Smith, 1894; Colima, 12 E. Palmer, July, 1897; between Huejuquilla and Mesquitec, State of Jalisco, 2582 J. N. Rose, August 25, 1897; a close compact-growing grass with long runners, forming a fine, close sod; spots of considerable size are found covered with it.

Cathestecum sp.

Monte Alban, State of Oaxaca, 950 C. L. Smith, 1894. This specimen is doubtfully referred to *Cathestecum*, but is very distinct from both *C. prostratum* Presl and *C. erectum* Vasey and Hack, and is seemingly intermediate between the genera *Cathestecum* and *Pentarrhaphis.* The material in the National Herbarium is in a too unsatisfactory condition for accurate determination.

Scleropogon brevifolius Philippi, Sert. Mendoc. **2:** 48 (1871).

Saltillo, State of Coahuila, 386 E. Palmer, September, 1898, common on dry hills.

Monanthochloe littoralis Engelm. Trans. Acad. Sci. St. Louis, **1:** 436. *tt. 13, 14* (1859).

Altata, State of Sinaloa, 1370 J. N. Rose, June 15, 1897.

Munroa squarrosa (Nutt.) Torr. Pac. R. R. Rept. **4**^{5}: 158 (1857). (*Crypsis squarrosa* Nutt. Gen. **1:** 49 (1818).)

Colonia Diaz, State of Chihuahua, 6440 E. W. Nelson, September 20–21, 1899.

Triodia acuminata Benth. in Vasey, U. S. Dept. Agr. Div. Bot. Spec. Rept. **63:** 35 (1883).

Saltillo, State of Coahuila, 262 E. Palmer, June, 1898, 813 E. Palmer, September, 1898, in dense tufts on dry rocky hills.

Triodia avenacea H. B. K. Nov. Gen. et Sp. Pl. **1:** 156, *t. 48* (1815).

Saltillo, State of Coahuila, 414 E. Palmer, September, 1898, on rocky hillsides, forming dense tufts.

Triodia pulchella H. B. K. Nov. Gen. et Sp. Pl. **1:** 155, *t. 47* (1815).

Durango, State of Durango, 740 E. Palmer, September, 1896; Saltillo, State of Coahuila, 257 E. Palmer, June, 1898, 413 E. Palmer, September, 1898; near Lake Santa Maria, State of Chihuahua, 6414 E. W. Nelson, September 7, 1899.

Eragrostis ciliaris (L.) Link, Hort. Berol. **1:** 192 (1827).

Acaponeta, Territorio de Tepic, 3135 J. N. Rose, June 23–30, 1897.

Eragrostis glomerata (Walt.) Dewey, Contr. U. S. Nat. Herb. **2:** 543 (1894). (*Poa glomerata* Walt. Fl. Car. 80 (1788); *Eragrostis conferta* Trin.) Near Cuernavaca, State of Morelos, 6605 C. G. Pringle, 1896.

Eragrostis limbata Fourn. Mex. Pl. **2:** 116 (1881).

On the road from Casas Grandes to Sabinal, State of Chihuahua, altitude 1,700 m., 6353 E. W. Nelson, September 4–5, 1899; plains near Sierra En Media, State of Chihuahua, 6466 E. W. Nelson, September 24–26, 1899.

Eragrostis lugens Nees, Agrost. Bras. 507 (1829).

Durango, State of Durango, 727 E. Palmer, September, 1896; Saltillo, State of Coahuila, 408 E. Palmer, September, 1898, a showy grass, growing in rich soil where stock could not reach it.

Eragrostis major Host, Gram. **4:** *t. 24* (1809).

Durango, State of Durango, 720 E. Palmer, September, 1896; Saltillo, State of Coahuila, 389 E. Palmer, September, 1898, in rich soil about dwellings, in gardens, etc.

Eragrostis mexicana Link, Hort. Berol. **1:** 190 (1827).

Durango, State of Durango, 531, 768, 875, E. Palmer, June–November, 1896; Colima, 20 E. Palmer, July, 1897; Torreon, State of Coahuila, 510 E. Palmer, October, 1898; Saltillo, 376, 409, 411 E. Palmer, September, 1898.

Eragrostis neo-mexicana Vasey, in Beal, Grasses N. A. **2**: 485 (1896).

Near Colotlan, State of Jalisco, 3605 J. N. Rose, August 29, 1897; Saltillo, State o Coahuila, 410, 412 E. Palmer, September, 1898; Sierra Madre Mountains, north of Pachico, State of Chihuahua, 6300 E. W. Nelson, August 25, 1899.

Eragrostis panamensis Presl, Rel. Haenk. **1**: 277 (1830).

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 1051 C. L. Smith, February, 1895, a robust form, distributed as *Eragrostis major* Host.

Eragrostis pilosa (L.) Beauv. Agrost. 71 (1812).

Durango, State of Durango, 726 E. Palmer, September, 1896; Saltillo, State of Coahuila, 811 E. Palmer, September, 1898.

Eragrostis plumosa Link, Hort. Berol. **1**: 192 (1827).

Colima, 15 E. Palmer, July, 1897, along roadsides, shady ravines, and in gardens.

Eragrostis purshii Schrad. Linnæa, **12**: 451 (1838).

Durango, State of Durango, 177, 183, 534, 723, 764, 869 E. Palmer, June–October, 1896; Rosario, State of Sinaloa, 1544, 1545 J. N. Rose, July 7, 1897, 1847 J. N. Rose, July 26, 1897; Guaymas, State of Sonora, 1281 J. N. Rose, June 5–11, 1897; Bolanos, State of Jalisco, 3699 J. N. Rose, September 10–19, 1897; between Agnacata and Dolores, Territorio de Tepic, 2016 J. N. Rose, August 6, 1897; Colima, 13 E. Palmer, 1897; Topolobampo, State of Sinaloa, 240 E. Palmer, September, 1897; Saltillo, State of Coahuila, 812 E. Palmer, September, 1898.

Eragrostis sessilispica Buckl. Proc. Acad. Nat. Sci. Phila. **1862**: 97 (1862).

Near Lake Santa Maria, State of Chihuahua, 6413 E. W. Nelson, September 7, 1899.

Eatonia obtusata A. Gray, in S. Wats. Bot. Calif. **2**: 302 (1880).

Durango, State of Durango, 255 E. Palmer, June, 1896.

Koeleria cristata (L.) Pers. Syn. **1**: 97 (1805). (*Aira cristata* L. Sp. Pl. 63 (1753).)

Near Colonia Garcia, Sierra Madre Mountains, State of Chihuahua, 6198 E. W. Nelson, August 1, 1899.

Distichlis prostrata (H. B. K.) Desv. Gram. Chil. 398 (1853). (*Poa prostrata* H. B. K. Nov. Gen. et Sp. Pl. **1**: 157 (1815).)

Durango, State of Durango, 182, 385(?), 388 E. Palmer, 1898, common in damp, alkali meadows.

Distichlis spicata (L.) Greene, Bul. Calif. Acad. Sci. **2**: 415 (1887). (*Uniola spicata* L. Sp. Pl. 71 (1753).)

Altata, State of Sinaloa, 1367 J. N. Rose, June 15, 1897; San Jose de Guaymas, 270 E. Palmer, October 14, 1897; near Lake Santa Maria, State of Chihuahua, 6461 E. W. Nelson, September 7, 1899. This grass is planted along ditches in sandy soil to prevent banks from washing.

Distichlis texana (Vasey) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **17**: 236, *fig. 532* (1899). (*Poa texana* Vasey, Contr. U. S. Nat. Herb. **1**: 60 (1890); *Sieglingia wrightii* Vasey, Contr. U. S. Nat. Herb. **1**: 269 (1893).)

Torreon, State of Coahuila, 507 E. Palmer, October, 1898, growing on sandy banks of the Nassus River.

Poa annua L. Sp. Pl. 68 (1753).

Nombre de Dios, State of Durango, 97 E. Palmer, April, 1896; Saltillo, State of Coahuila, 6 E. Palmer, April, 1899, about dwellings.

Poa infirma H. B. K. Nov. Gen. et Sp. Pl. **1**: 158 (1815).

Near Plateado, State of Zacatecas, 2712 J. N. Rose, September 1, 1897.

* **Poa pratensis** L. Sp. Pl. 67 (1753).

Mountains near Jalapa, State of Vera Cruz; altitude, 1,750 m.; 7880 C. G. Pringle, April–May, 1899.

Graphephorum altijugum Fourn. Bul. Soc. Bot. Fr. **24**: 182 (1877).

Sierra de San Felipe, State of Oaxaca, 941 C. L. Smith, 1894.

Festuca amplissima Rupr. Bul. Acad. Brux. **9**^{2}: 236 (1842).

Sierra de San Felipe, State of Oaxaca, 924 C. L. Smith, September, 1894; Durango, State of Durango, 2358 J. N. Rose, August 16, 1897, small form.

Bromus carinatus arizonicus Shear, U. S. Dept. Agr. Div. Agros. Bul. **23:** 61 (1900).

Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 2138 J. N. Rose, August 9, 1897.

Bromus ciliatus L. Sp. Pl. 76 (1753).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 925 C. L. Smith, September, 1894.

Bromus compressus Lag. Elench. 4 (1816).

Saltillo, State of Coahuila, 5 E. Palmer, April, 1898; 366 E. Palmer, September, 1898, in alfalfa, along irrigating ditches.

Bromus laciniatus Beal, Grasses N. A. **2:** 615 (1896).

Sierra de San Felipe, State of Oaxaca, 942 C. L. Smith, September, 1894.

Bromus porteri frondosus Shear, U. S. Dept. Agr. Div. Agros. Bul. **23:** 37 (1900).

Near Plateado, State of Zacatecas, 2727 J. N. Rose, September 1, 1897.

BROMUS SCHAFFNERI (Fourn.) Scribn. & Merrill, n. comb. (*Bromus hookeri schaffneri* Fourn. Mex. Pl. **2:** 127 (1881).)

Durango, State of Durango, 171 E. Palmer, June, 1896, 743 E. Palmer, September, 1896.

Agropyron arizonicum Scribn. & Smith, U. S. Dept. Agr. Div. Agros. Bul. **4:** 27 (1897).

Base of Sierra Madre Mountains, State of Chihuahua, near the border of Mexico, 6495 E. W. Nelson, September 29, 1899.

Elymus brachystachys Scribn. & Ball. (p. 47).

Saltillo, State of Coahuila, 260 E. Palmer, June, 1898.

ELYMUS PRINGLEI Scribn. & Merrill, sp. nov.

A slender, erect, cæspitose perennial, 6 to 9 dm. high, with slender culms, linear or linear-lanceolate leaves and rather loosely flowered, pale green panicles 4 to 12 cm. long. Culms very slender, glabrous, often somewhat geniculate below; nodes smooth; sheaths smooth, striate, mostly shorter than the internodes; ligule hyaline, obtuse, slightly toothed, about 1 mm. long; leaf-blades 10 to 20 cm. long, 3 to 8 mm. wide, scabrous on both sides. Rachis somewhat compressed, slightly scabrous, somewhat strigose above, the internodes shorter than the spikelets. Spikelets 2 at each node, 3 to 4 flowered, about 10 mm. long, exclusive of the awns; empty glumes subequal, scabrous, subulate-setaceous, about 22 mm. long; flowering glumes lanceolate, acuminate, 5-nerved, strigose-pubescent, with rather short, stiff hairs, especially above, bearing a straight, slender, scabrous awn 8 to 15 mm. long. Palea lanceolate, obtuse, strongly serrulate-scabrous on the margins above, 7 to 8 mm. long.

Type specimen collected in wet soil in a valley near Tula, State of Hidalgo, altitude 2,200 m., 6637 C. G. Pringle, June 8, 1897, distributed as *Elymus botteri;* 7165 C. G. Pringle, same locality, October 24, 1896, belongs here.

This species differs from *E. interruptus* Buckl. in its slender habit, narrower, setaceous empty glumes, and strongly strigose-pubescent flowering glumes.

***Sitanion brevifolium** J. G. Smith, U. S. Dept. Agr. Div. Agros. Bul. **18:** 17 (1899).

Cerro Ventoso, above Pachuca, State of Hidalgo, altitude 2,600 m., 6944 C. G. Pringle, August 18, 1899.

Arundinaria longifolia Fourn. Mex. Pl. **2:** 131 (1881).

Between Pedro Paulo and San Blascito, Territorio de Tepic, 3344 J. N. Rose, August 4, 1897; near Huasemote, State of Durango, 3494 J. N. Rose, August 15, 1897.

II. NOTES ON PANICUM NITIDUM LAM., PANICUM SCOPARIUM LAM., AND PANICUM PUBESCENS LAM.

By F. Lamson-Scribner and Elmer D. Merrill.

While in Paris in March and April, 1900, Mr. A. H. Baldwin, an artist of the Department, made careful drawings and notes on some of Michaux's and Lamarck's types in the Herbarium of the Muséum d'Histoire Naturelle de Paris, and among them were found the types or at least typical material of *Panicum nitidum*, *Panicum pubescens*, and *Panicum scoparium*. As none of these species have been understood by American authors, the following notes on the results of studying these types will clear up the existing confusion regarding the identity of these species. F. L.-S.

PANICUM NITIDUM Lam.

Lamarck first characterized *Panicum nitidum* in his Tabl. Encycl. **1**: 172 (1791), as follows:

> "899. *Panicum nitidum.*
>
> "P. panicula ramosa subviolacea, glumis obtusis striatis, semine nitido.
>
> "E Carolinia Com. D. Fraser.".

Later in his Encycl. **4**: 738 (err. typ. 748) (1797), he more fully characterized the species with the following description:

> "*Panic luisant; Panicum nitidum.* Illustr. no. 899.
>
> "Panicum panicula ramosa subviolacea, glumis obtusis striatis hispidulis, semine nitido.
>
> "Sa tige est à peine hautre d'un pied, glabre, articulée, feuillée. Les feuilles sont larges de deux ou trois lignes, glabres, excepté à l'entrée de leur gaîne, qui est longue et striée. La panicule est médiocre, rameuse, longue de deux à trois pouces, et teinte d'un violet-brun, ainsi que les articulations de la tige. Les fleurs sons ovales, obtuses, mutiques, striées, légèrement hispides, d'un vert teint de violet-brun. Les graines sont très luisantes.
>
> "Cette graminée croît dans la Caroline, où elle a été recueillie par Fraser, naturaliste anglois (v. s.). Le citoyen Michaux l'a aussi trouvée dans diferentes parties de l'Amérique septentrionale; et il en a recueilli dans la Pensylvanie une variété à fleurs plus petites et à feuilles fort étroites."[1]

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[1] The culm is scarcely a foot high, glabrous, articulate, leafy. The leaves are 2 or 3 lines wide, glabrous, except at the beginning of the sheath, which is long and striate. The panicle is medium, branching, 2 to 3 inches long and of a violet-brown color, as are also the articulations of the stem. The flowers are oval, obtuse, muticous, striate, slightly hispid, green tinted with violet-brown. The grain is very shining.

This grass grows in Carolina, where it was collected by Fraser, an English naturalist (v. s.). Michaux also found it in different parts of North America, and he collected in Pennsylvania a variety with smaller flowers and very narrow leaves.

Michaux, Fl. Bor. Am. **1**: 49 (1843), gives some additional characters for this species in the following description:

> "*Panicum nitidum* Lam. P. glabrum, vaginarum collo barbato culmo gracili, simplici, erecto; foliis paucissimis, remotis, lanceolato-linearibus; panicula capillari, confertiuscula, composite ramosa, glabra; floribus pusillis, obtuse ovatis, minutissime puberulis; valvula extima vix perceptibili.
>
> "Hab. in Pennsylvania et Carolina."

Michaux's plant (fig. 8) in the Herbarium of the Paris Museum of Natural History bears the following label: "Herb. Mus. Paris, Herbier de l'Amérique septentrionale d'André Michaux: Panicum nitidum Lam. Hab. en Pensylvanie, Carolina."

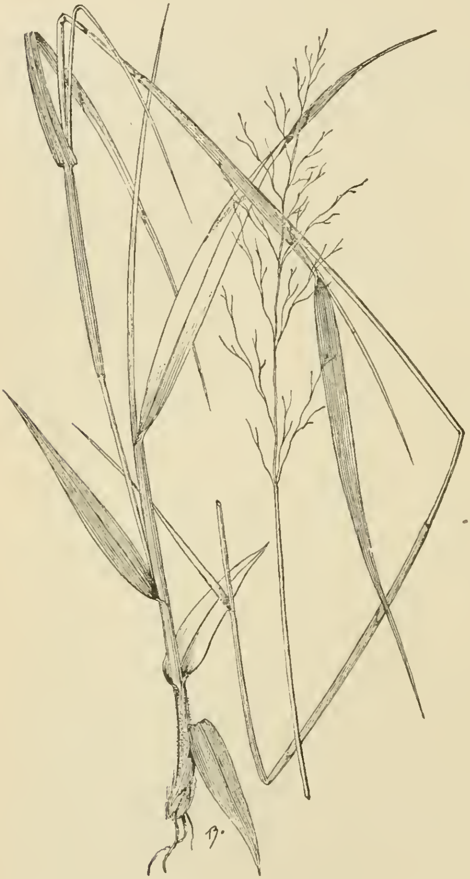

Fig. 8.—*Panicum nitidum* Michx., drawn from specimen in the Herbarium of the Muséum d'Histoire Naturelle de Paris by A. H. Baldwin.

While Lamarck first cites Fraser's plant, yet, judging from his description and from the fact that he evidently had both Fraser's and Michaux's plants in his possession at the time he wrote the longer description, there can be little doubt as to their identity.

We believe that Michaux's plant should be considered as typical *Panicum nitidum* Lam., at least until positive proof is given that it is different from Fraser's plant cited by Lamarck.

Panicum nitidum has never been understood by American authors, and many forms have been referred to it by different authorities. Unfortunately no spikelets remain on Michaux's plant, but a careful study of the above descriptions and the drawing of Michaux's plant leads us to consider *Panicum nitidum* as follows:

Panicum nitidum Lam. Tabl. Encycl. **1**: 172 (1791); Encycl. **4**: 738 (err. typ. 748) (1797); *Panicum* No. 37 (sine nomine) Muhl. Descr. 125 (1817); *Panicum spretum* Schultes, Mant. **2**: 248 (1824); *Panicum nitidum* forma *densiflorum* Rand. & Redfield, Fl. Mt. Desert Isl. 174 (1894); *Panicum eatoni* Nash, Bull. Torr. Bot. Club, **25**: 84 (1898); *Panicum paucipilum* Nash, ibid. **26**: 573 (1899).

A glabrous, tufted perennial 6 to 10 dm. high, with erect, narrowly lanceolate leaves, and exserted, contracted panicles, bearing numerous, small, purplish, pubescent spikelets. Culms at first simple, becoming dichotomously branched, generally purplish; nodes smooth; sheaths much shorter than the internodes, glabrous, striate, usually slightly ciliate on the margins above; ligule a dense ring of hairs about 2 mm. long; leaf-blades 5 to 10 cm. long, 3 to 10 mm. wide, acuminate, glabrous, or with few papillate hairs at the base. Panicle finally long-exserted, generally contracted, 5 to 13 cm. long; rachis glabrous; branches erect or ascending. Spikelets ovate, 1.4 to 1.6 mm. long; first glume small, one-fourth to one-third as long as the spikelet, glabrous, 1-nerved; second and third glumes pubescent with spreading hairs, often densely so, 7-nerved; flowering glume about 1.3 mm. long.

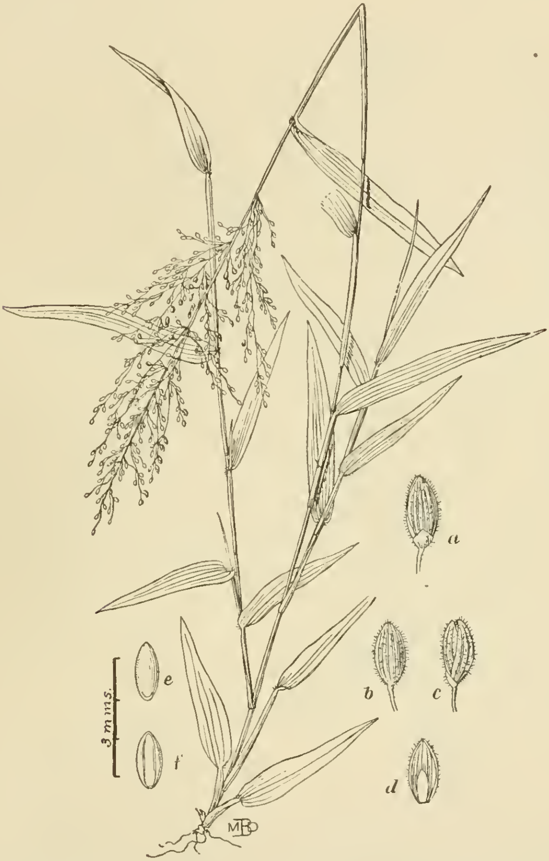

Fig. 9.—*Panicum catoni* Nash: *a, b, c*, spikelets; *d*, anterior view of third glume, showing small palea *e*, flowering glume, dorsal view; *f*, the same, anterior view, showing palea.

Type locality.—Carolina and Pennsylvania. Type specimen in the Herbarium of the Paris Museum of Natural History.

General distribution.—In wet soil, especially near the coast, Maine to Mississippi, and Texas. May to September.

Specimens examined.—*Maine:* Shore of Chase's Pond, York, 510 M. L. Fernald, 1891. *Massachusetts:* Essex County, W. P. Conant, 1891; Stoneham, 320, 336, 349 W.

P. Rich, 1894. *Rhode Island:* Johnston, J. W. Congdon, 1871. *Connecticut:* Waterford, 87 C. B. Graves, 1898. *New Jersey:* Atsion, 44 A. Commons, 1882; Gloucester County, 2 B. Heritage, 1897. *Mississippi:* Beauvoir, 4594 S. M. Tracy, 1898.

The habit of Michaux's plant, as shown by figure 8, is so characteristic and so closely resembles *Panicum eatoni* (Fig. 9) that we have no hesitation in referring *Panicum eatoni* to *Panicum nitidum*. *Panicum paucipilum* can not be satisfactorily distinguished from *P. eatoni*, either by the original descriptions or by comparison of typical material. The culms, sheaths, ligules, leaves, panicles, and spikelets are the same, and moreover both forms grow in moist places. Mr. Nash[1] states that *Panicum paucipilum* can be distinguished from *P. eatoni* by its *much smaller spikelets*, with the first glume glabrous and orbicular. The difference in measurements of the spikelets given by Mr. Nash is but 0.2 mm., and according to his original description and to specimens examined the first glume of *P. eatoni* is also glabrous! The type of *Panicum spretum* Schultes in Muhlenberg's Herbarium in the Academy of Nat. Sci. of Phil. is identical with *P. eatoni* Nash., the form with the dense contracted panicles.

The figure of *Panicum eatoni* above has shorter and broader leaves than in the type.

PANICUM NITIDUM OCTINODUM (Smith) n. comb. (*Panicum octinodum* Smith, U. S. Dept. Agr. Div. Agros. Bul. **17**: 73, *fig. 369* (June 30, 1899); Scribn. & Smith, ibid. Cir. **16**: 5 (July 1, 1899).) (Fig. 10.)

A form which differs from typical *Panicum nitidum* only in having smooth spikelets.

Type locality.—Waller County, Texas.

General distribution.—In ponds and exsiccated swamps, Delaware and Texas.

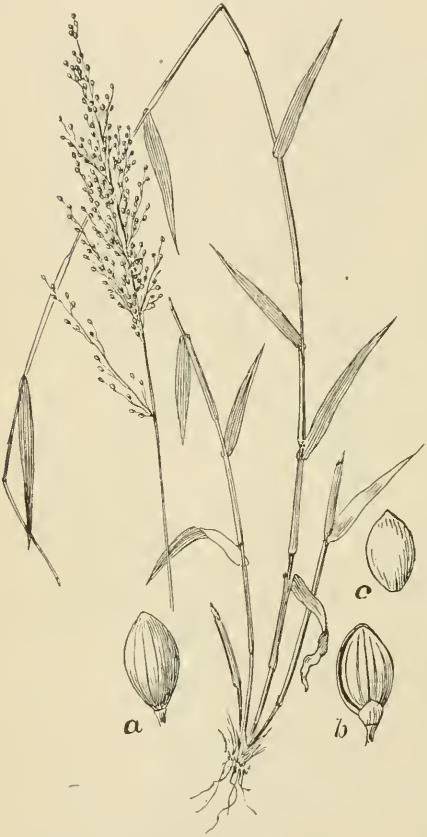

Fig. 10.—*Panicum nitidum octinodum* (Smith): *a, b*, spikelets; *c*, flowering glume.

Specimens examined.—*Delaware:* Townsend, W. N. Canby, 1891; Cape Henlopen, 340 A. Commons, 1898. *Texas:* Waller County, F. W. Thurow, 1898 (type).

PANICUM SCOPARIUM Lam.

Panicum scoparium Lam. Encycl. **4**: 744 (1797!); Michx. Fl. Bor. Am. **1**: 49 (1803!), not of authors. (*Panicum pubescens* Lam. l. c. 748!; Michx. l. c.!, not of authors. *Panicum viscidum* Ell. Sk. Bot. S. C. and Ga. **1**: 123 (1817!). (Fig. 11.)

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[1] Bul. Torr. Bot. Club, **26**: 574 (1899).

A rather stout, erect or ascending and finally much-branched perennial, 3 to 14 dm. high, with the culms and sheaths usually densely pubescent with spreading or reflexed canescent hairs, and all parts somewhat viscid when fresh. Culms stout, often purplish; nodes bearded and with a glabrous ring immediately below; sheaths shorter than the internodes; ligule a dense ring of hairs about 2 mm. long; leaf-blades lanceolate, gradually tapering from near the middle to the very acute apex, subcordate at the base, softly pubescent on both sides, minutely scabrous on the margins, villous on the back at the point of union with the sheath, basal ones ovate, 5 to 10 cm. long, obtuse, those of the primary culm 12 to 25 cm. long, 10 to 20 mm. wide, those of the branches densely crowded and much smaller, 2 to 5 cm. long. Panicles 6 to 15 cm. long, ovate or subpyramidal; rachis more or less pubescent; branches compound to the base, flexuous; pedicels usually much longer than the spikelets. Spikelets 2 to 2.5 mm. long, ovate or ovate-lanceolate, acute; first glume minute, one-fourth as long as the spikelet or less, usually nerveless; second and third glumes strongly pubescent, 9-nerved. Below each of the nodes there is a smooth space about 4 mm. broad, extending around the stem like a ring; the nearly smooth upper portions of the sheaths and panicle branches are mottled with irregular yellow or brown, often purple-bordered spots. In the early flowering stage the culms are nearly always simple and support a single, long-exserted panicle; later the culms become much branched and the branches are terminated by more simple, fewer-flowered panicles which are partially inclosed in the leaf-sheaths. The primary panicle and sometimes the first culm leaves disappear and there is left a much-branched grass with numerous crowded small leaves and many, small, few-flowered, simple panicles. It was this late, much-branched form that Lamarck described as *Panicum pubescens.*

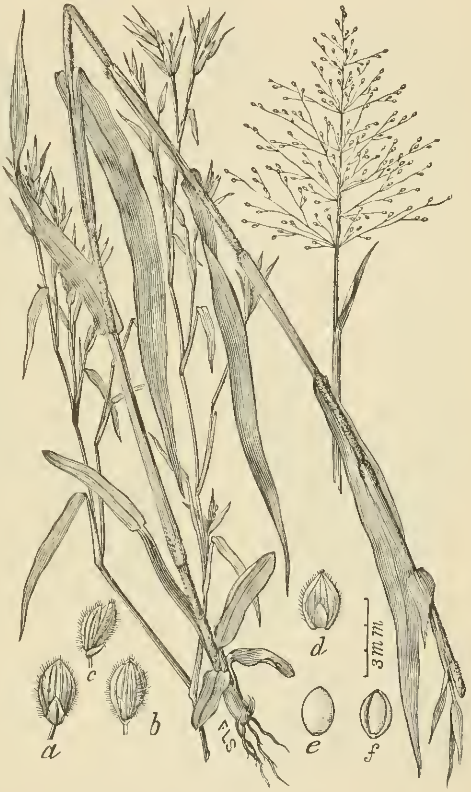

Fig. 11.—*Panicum scoparium* Lam: *a, b, c,* spikelets; *d,* third glume with palea; *e, f,* flowering glumes.

Type locality.—"Carolina," Michaux. Type specimen in the Herbarium of the Paris Museum of Natural History.

General distribution.—Low ground, swamps, borders of thickets, etc., Pennsylvania to Tennessee, Florida, Arkansas, and Texas. May to October.

Specimens examined.—*Pennsylvania:* J. McMinn, no locality or date. Tinicum, 114 C. E. Smith; *Delaware:* Ellendale, 32 A. Commons, 1892; Millsboro, 28 A.

Commons, 1894. *District of Columbia:* G. Vasey, 1881; D. L. Topping, 1895; T. H. Kearney, 1895; Deanwood, E. D. Merrill, 1900. *Virginia:* Norfolk, 308 T. H. Kearney, 1895; Portsmouth, 88, 89 Noyes, 1896; Dismal Swamp, G. McCarthy, 1883. *North Carolina:* Wilmington, 4290 Biltmore Herbarium, 1897. *Georgia:* Yellow River, Gwinnett County, J. K. Small, 1893; Americus, S. M. Tracy, 1897. *Alabama:* Tuskegee, 52, 87 G. W. Carver, 1897; Cullman, C. Mohr, 1895; Auburn, 3978 S. M. Tracy, 1897. *Florida:* Baldwin, 67 R. Combs, 1898; Chipley to Bay Head, 616 Combs, 1898; Duval County, A. H. Curtiss; Apalachicola, A. W. Chapman, 4290*a* Biltmore Herbarium; Lake City, 2204 G. V. Nash, 1895. *Mississippi:* Pachuta, 3306 S. M. Tracy, 1897. *Louisiana:* Arcadia, 77 C. R. Ball, 1898. *Arkansas:* F. L. Harvey; Miller County, 116 H. Eggert, 1896; Texarkana, 4236 A. A. & E. G. Heller, 1898. *Texas:* Waller, F. W. Thurow, 1898; Fort Smith to Rio Grande, Choctaw Agency, J. M. Bigelow, 1853–54; Hempstead, 829 E. Hall, 1872; no locality, G. C. Nealley.

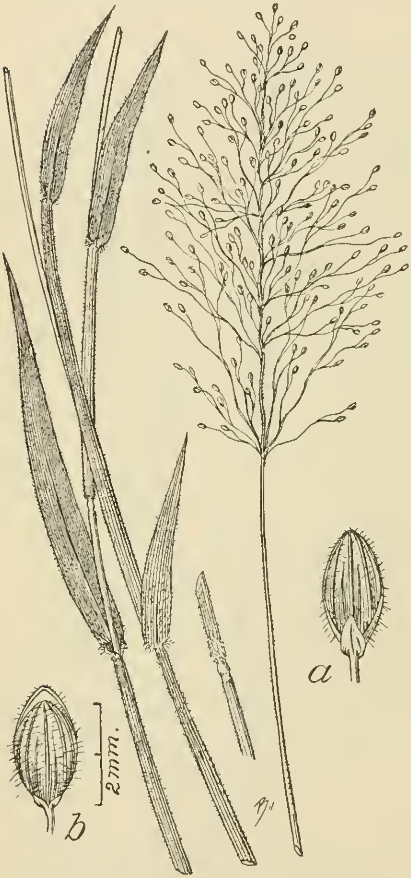

FIG. 12.—*Panicum scoparium* Lam: *a*, *b*, spikelets. Drawn from type specimen in the Herbarium of the Paris Museum of Natural History.

There are two sheets of *Panicum scoparium* in the Herbarium of the Paris Museum, one with the following label: "*Panicum scoparium* Lam. donné par le C. Michaux, Herb. Mus. Paris, Herbier de Lamarck acquis en novembre, 1886," which is evidently Lamarck's type. (Fig. 12.) The second sheet is identical with this and bears the following label: "*Panicum scoparium* Lam. in pratis sylvestris, Carolina, Herb. Mus. Paris, Herbier de l'Amérique septentrionale d'André Michaux." Some American authors have recognized that *Panicum scoparium* of Michaux was identical with *P. viscidum* Ell., but wrongly considered Michaux's plant distinct from *Panicum scoparium* Lam. Both Lamarck's and Michaux's specimens of *P. scoparium* are identical with the form long known as *Panicum viscidum* Ell. For the plant wrongly considered by Elliott as *Panicum scoparium*, we propose the following name: **Panicum ravenelii** Scribn. & Merrill, nom. nov. (*Panicum scoparium* of Ell. Sk. Bot. S. C. and Ga. **1**: 119. 1817. Not Lam. Encycl. **4**: 744. 1797.)

Panicum pubescens Lam. is a late, much-branched form of *Panicum scoparium* Lam. In the Herb. Mus. Paris there is one sheet of this species bearing the following label: "*Panicum pubescens* Lam., Hab. in pratis sylvestribus Carolinæ ♃, no. 7, Herb. Mus. Paris, Herbier de l'Amérique septentrionale d'André Michaux." On this sheet are two specimens, one a fragment much dried and torn, the other in good condition. (Fig. 13.) These specimens are identical and are matched by the following collections: 77 C. R. Ball, Louisiana, 1898; 3978 S. M. Tracy, Alabama, 1897.

While it is possible that the specimen cited by Lamarck as collected by Sherard in 1721 may be different from Michaux's plant, yet Lamarck's description is certainly that of the latter.

The appearance of the early simple form and the late branched form of this species is so different that it is not to be wondered at that Lamarck considered them distinct species and so described them, especially as he had only herbarium material to deal with.

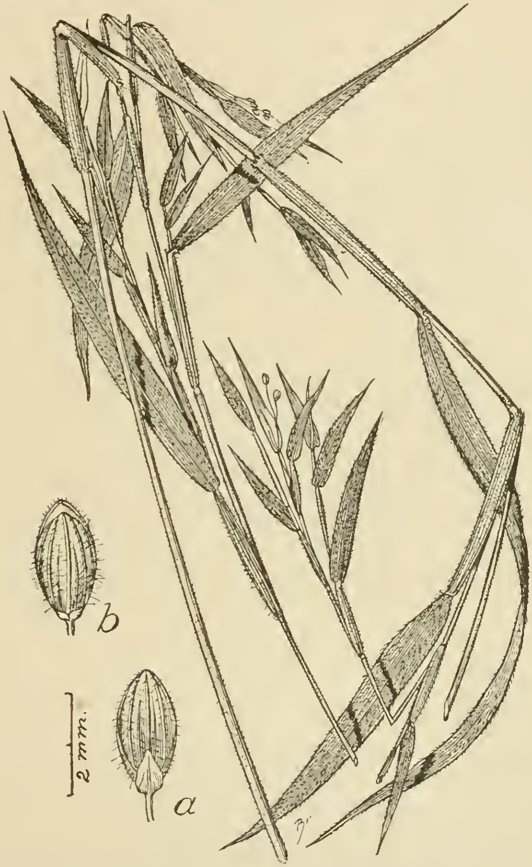

FIG. 13.—*Panicum pubescens* Lam: *a*, *b*, spikelets. Drawn from a specimen in the Herbarium of the Paris Museum of Natural History, by A. H. Baldwin.

The original descriptions of *Panicum scoparium* and *Panicum pubescens* are given below:

"*Panic en balais; Panicum scoparium.*

"Panicum panicula ramosa subnudiflora, glumis ovatis striatis villosulis, foliis brevibus pubescentibus.

"D'après les exemplaires de cette plante que j'ai vus dans l'herbier du citoyen Jussieu, sa tige doit avoit environ un pied & demi de longueur. Elle est articulée, feuillée médiocrement, simple, pubescente. Les feuilles sont distantes, courtes, ovales-lancéolées, pointues, pubescentes, & larges d'environ six lignes. La panicule est terminale, longue de quatre ou cinq pouces, rameuse, velue sur son axe & ses principales ramifications, & paroît en grand partie dénuée de fleurs, sans doute par l'effet de la chûte prompte de celles qui se sont développées les premières. Les fleurs sont un peu pédicellées, ovales, striées, velues, mutiques. La troisième valve calicinale est courte, pointue, bien apparente.

"Cette plante a été recueillie dans la Basse-Caroline par le citoyen Michaux (v. s.)."[1] Lamarck, Encycl. **4**: 744 (1797).

This plant was collected in South Carolina by Michaux (v. s.).

"*Panic pubescent; Panicum pubescens.*

"Panicum pubescens panicula parva laxa sessili pauciflora, glumis ovatis subpedicellatis, culmo superne ramosissimo.

"Les tiges, les feuilles, la panicule & les bâles sont couvertes d'un duvet court, très-remarquable, qui donne à la plante une couleur cendrée ou blanchâtre. La tige, qui quelquefois n'a guère plus de six pouces de hauteur, s'élève d'autres fois à la hauteur d'un pied ou un peu plus. Elle est un peu coudée à ses articulations, dont les inférieures sont fréquentes, & se divise dans sa partie superieure en plusieurs ramifications presque dichotomes. Ses feuilles sont graminées, planes, ou presque planes, larges de deux à trois lignes, d'un vert glauque ou grisâtre, & pubescentes des deux côté, ainsi que sur leur gaîne. Les panicules sont terminales, petites, très-lâches, sessiles, & composées de trois ou quatre ramifications alternes, distantes & pauciflores. Les bâles sont ovales, un peu pédicellées & pubescentes comme les autres parties de la plante. J'ai vu de cette espèce un individu nain dans l'herbier de Vaillant; il l'avoit reçue de Sherard en 1721. Le citoyen Michaux l'a trouvée dans la Basse-Caroline (v. s.)."[2] Lamarck, Encycl. **4**: 748 (1797).

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[1] According to specimens of this plant which I have seen in the herbarium of Jussieu, the culm was about a foot and a half high. It is articulate, sparingly branched, simple, pubescent. The leaves are distant, short, oval-lanceolate, pointed, pubescent, and about 6 lines wide. The panicle is terminal, 4 or 5 inches long, branching, downy on its axis and its principal branches, and seems to be almost entirely bare of flowers, doubtless due to the early fall of those which developed first. The flowers are short-pedicelled, oval, striate, downy, muticous. The third glume is short, pointed, very prominent.

[2] Culms, leaves, panicle, and spikelets are covered with a very peculiar short down, which gives the plant an ashy or whitish color. The culm, which sometimes is not more than 6 inches high, at other times reaches the height of a foot or more. It is slightly bent at its articulations, the lower of which are numerous, and is divided above into several nearly dichotomous branches. The leaves are grasslike, flat, or nearly so, 2 or 3 lines wide, glaucous green or grayish, and pubescent on both sides, as is also the sheath. The panicles are terminal, small, very lax, sessile, and composed of three or four alternate branches, distant and few-flowered. The spikelets are oval, shortly pedicelled and pubescent like the other parts of the plant. I have seen a dwarfed individual of this species in the herbarium of Vaillant, who had received it from Sherard in 1721. Michaux found it in South Carolina (v. s.).

III.—MISCELLANEOUS NOTES AND DESCRIPTIONS OF NEW SPECIES.

By F. Lamson-Scribner and Carleton R. Ball.

The notes and new species presented in the following pages were for the most part elaborated in the preparation of a complete list of the grasses of the Gulf States to accompany a report on the economic grasses of that region. It is believed that the recognition of the five species of *Elymus* will greatly facilitate a better understanding of that genus in the Eastern and Southern States, from both the economic and systematic standpoints. F. L.-S.

ANDROPOGON ARGYRÆUS MACRUS Hack. in litt.

Sheaths mostly sparingly long-hirsute; leaves scabrous or sometimes sparingly hirsute above; spikes 1 to 2 cm. long; spikelets 6 to 7 mm. long, otherwise as in the species.

Type collected by S. M. Tracy, No. 3891, Biloxi, Mississippi, October 31, 1897.

Specimens examined.—*Florida:* Apalachicola, A. W. Chapman; McDonald, Orange Co., 57 C. H. Baker, November, 1897. *Mississippi:* Biloxi, 3892, 3900 S. M. Tracy, October, 1898; Columbus, 2954 S. M. Tracy, October, 1895.

ANDROPOGON BAKERI sp. nov. (Fig. 14.)

A tall, stout perennial, with the short spikes borne on long, slender peduncles; Culms 10 to 11 dm. high, smooth or slightly roughened below the upper nodes. lower internodes strongly compressed, the upper terete; sheaths much longer than the internodes, loose, smooth or sparsely hirsute, the lower compressed, keeled, equitant, the upper inclosing the bases of the panicles; ligule membranous, 1 mm. long, fringed with short bristles; leaf-blades 2 to 4 dm. long, 5 to 7 mm. wide, flat, smooth below, somewhat scabrous above. Panicle about 2.5 cm. long, with slender, appressed or somewhat spreading branches, 3 to 4 at each node; joints of the primary branches 3 to 4, secondary 2 to 3, and tertiary usually 1. Spathes 4 to 5 cm. long, green, acuminate, exceeding or somewhat shorter than the racemes. Racemes two, 1.5 to 3 cm. long, 3 to 6 flowered; rachis slender, internodes somewhat clavate, 4 mm. long, shorter than the spikelets, densely clothed with long, silky, white hairs, exceeding the internodes in length. Sessile spikelets yellowish, linear-lanceolate, 5 mm. long; callus barbate with white hairs 2 mm. long; first glume smooth or the keels minutely scabrous, bifid at the apex, 5 mm. long; second glume firm, keeled, scabrous on the keel, 4.5 mm. long, bidentate at apex; third glume hyaline, acuminate; fourth glume hyaline, acuminate, bifid at the apex, and bearing a straight, slender awn 7 to 10 mm. long. Grain fusiform, plano-convex, acute at apex, 3.5 mm. long, tipped with the persistent style. Sterile pedicel about 7 mm. long, erect, densely clothed with long white hairs; sterile spikelet entirely wanting.

Type collected in pine lands at Grasmere, Florida, 58 C. H. Baker, November 13, 1897.

ANDROPOGON LINNAEANUS (Hack.) Scribn. & Kearney, n. comb. (*Sorghum nutans Linnaeanum* Hack. in Mart. Fl. Bras. **2**^{3}: 276 (1878); *Andropogon nutans Linnaeanus* Hack. in DC. Monog. Phan. **6**: 531 (1889).)

ANDROPOGON MISSISSIPPIENSIS sp. nov. (Fig. 15.)

A rather small perennial, 4 to 7 dm. high, with few, short-peduncled spikes. Culms slender, smooth, purplish where exposed, the lower internodes somewhat compressed; sheaths about one-half as long as the internodes, strongly striate, densely hirsute or papillose-hirsute with white hairs 2 to 3 mm. long, the lower ones equitant, crowded; ligule a very short membranous ring; leaf-blades 1 to 2.5 dm. long, 2 to 3 mm. wide, acuminate, flat, hirsute below, papillose-hirsute above, midrib and margins strongly scabrous. Panicle 2 to 2.5 dm. long, slender, interrupted, nearly simple; branches 7 to 15 cm. long, appressed, single, 2-noded. Spathe 4 to 4.5 cm. long, equaling or shorter than the racemes, abruptly acuminate into an awn 2 to 3 mm. long. Racemes in pairs, 2 to 4 cm. long, 6 to 12 flowered; internodes somewhat clavate, shorter than the spikelets, 2.5 mm. long, densely clothed with long, white, silky hairs, 5 to 7 mm. long; sessile spikelet yellowish, linear-lanceolate, 4 mm. long; callus barbate with hairs 3 mm. long; first glume hispid-scabrous on the flat or depressed back and on the keels, especially toward the apex, nerveless between the keels, 3.5 to 4 mm. long, 1 to 1.2 mm. broad; second glume firm, strongly compressed, keeled, scabrous on the keel, hirsute on the margins, 3.5 mm. long, bidentate at the acute apex; third and fourth glumes hyaline, acuminate, the fourth bearing an erect, slender awn, twisted at the base, 1.5 to 2 cm. long; sterile pedicel 4 mm. long, slender, densely clothed with long, white, silky hairs; sterile spikelet reduced to a single scale 2 to 3 mm. long.

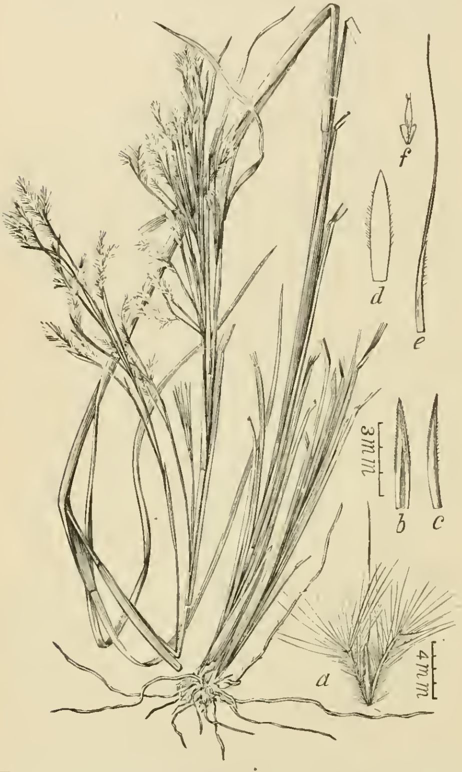

FIG. 14.—*Andropogon bakeri* Scribn. & Ball: *a*, a spikelet and joint of the axis; *b*, first glume; *c*, second glume; *d*, third glume; *e*, awned fourth glume; *f*, pistil and lodicules.

Related to *A. argyræus*, but easily separated by the hirsute sheaths and leaves, the narrow, simpler, interrupted panicle, and broader, scabrous first glume. Distinguished from *A. cabanisii* by its hirsuteness and by the nerveless intercarinal space of the first glume.

Type collected at Biloxi, Mississippi, 3818 S. M. Tracy, October 14, 1897. No. 3817 S. M. Tracy also belongs here.

ANDROPOGON SCOPARIUS POLYCLADUS var. nov.

Stout, 9 to 12 dm. high, glabrous, somewhat glaucous; panicles large, much branched, 3 to 5 dm. long.

Type collected at Braidentown, Manatee County, Florida, 1298 Robert Combs, October 3, 1898. "In old fields and orange groves along the Manatee; abundant in places." Tracy's No. 5330, from Biloxi, Mississippi, and a plant collected by John K. Small on the slopes and summit of Stone Mountain, Georgia, September 6–12, 1894, belong here.

ANDROPOGON SCOPARIUS VILLOSISSIMUS Kearn. var. nov.

Sheaths and usually the blades villous.

Type collected in very dry soil along the railroad at Waynesboro, Mississippi, 136 T. H. Kearney, jr., October 2, 1896. Other specimens are: *North Carolina:* Clarkton, Bladen County, 20*b* Biltmore Herbarium, October, 1897. *Florida:* Grasmere, 1156 R. Combs and C. H. Baker, September, 1896; McDonald, Orange County, 139 C. H. Baker, November, 1898; Tampa, 1371 R. Combs, October, 1898. *Mississippi:* Saltillo, S. M. Tracy, October 18, 1892. *Louisiana:* Lake Charles, 3702, 3703 S. M. Tracy, August, 1897; Oberlin, 219 C. R. Ball, September, 1898.

Paspalum altissimum Le Conte, Journ. Phys. **91**: 285 (1820).

"13. *Altissimum.* Glabrum, erectum, altum; foliis longis, basi vaginisque ad oras ciliatis; spicis 4–5 alternis, erectis, basi pilosis; glumis magnis, orbiculatis, biseriatis; rachi latiuscula, dentibus unifloris. Gramen rigidum, quinque pedale. Habitat prope Salem Carolinæ borealis. ♃."

Dr. Vasey, in his notes on Le Conte's *Paspalums*,[1] refers this to *P. floridanum* Mx., with which it has always been confounded. He also calls attention to the fact that Le Conte's type has but two racemes, although the description reads "racemis 4–5." Le Conte described a form of *P. læve* Mx. as *P. floridanum* Mx.

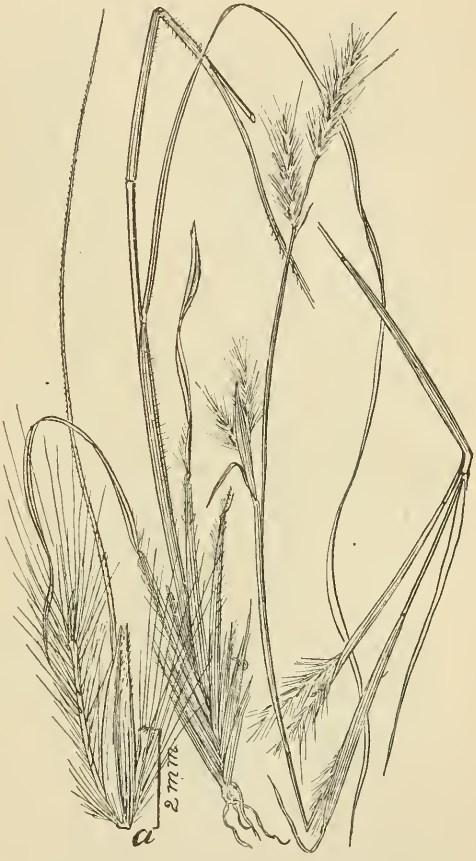

Fig. 15.—*Andropogon mississippiensis* Scribn. & Ball: *a*, a spikelet, showing joint of axis, etc.

P. altissimum is intermediate between *P. floridanum* Mx. and *P. bifidum* (Bertol) Nash, with slender, erect culms, hirsute sheaths and long, slender leaves, hirsute above and often below also. Racemes 1 to 3, rather loosely flowered.

General distribution.—Not uncommon in rather dry, open pine lands near the coast, from the Carolinas to Louisiana.

Specimens examined.—*South Carolina:* Florence, 688 C. R. Ball, August, 1900. *Florida:*

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[1] Proc. Acad. Nat. Sci. Phil. **1886**: 288 (1886).

no locality, A. W. Chapman; Bay Head, 636 R. Combs, August, 1898; Chipley, 594 R. Combs, August, 1898; De Funiak Springs, 471 R. Combs, August, 1898; Jacksonville, 149 T. H. Kearney, jr., July, 1895; Marianna, 3669 S. M. Tracy, August, 1897; Monticello, 343 R. Combs, August, 1898. *Georgia:* Thomasville, 3671 S. M. Tracy, August, 1897. *Alabama:* no locality, 333 A. Winchell; Mobile, C. Mohr. *Mississippi:* Bay St. Louis, 21 A. B. Langlois, September, 1883; Biloxi, 3743 S. M. Tracy, September, 1897; Nicholson, 345 T. H. Kearney, jr., 1896; Ocean Springs, 23 S. M. Tracy, August, 1889; 289 T. H. Kearney, jr., October, 1896; Waynesboro, 143 T. H. Kearney, jr., October, 1896. *Louisiana:* Alexandria, 171 C. R. Ball, September, 1898.

PASPALUM PASPALOIDES VILLOSUM (Vasey) n. comb. (*P. furcatum villosum* Vasey, Contr. U. S. Nat. Herb. **3:** 16 (1892).)

PANICUM COMBSII sp. nov. (Fig. 16.)

A slender, rather densely caespitose, erect perennial 3 to 6 dm. high, from short, creeping root-stocks, with linear flat leaves and spreading, nearly simple, few-flowered panicles 8 to 15 cm. long. Culms somewhat compressed below, glabrous or minutely puberulent just below the nodes; sheaths more or less compressed, glabrous; ligule very short, ciliate; leaves of the culm 10 to 20 cm. long, 3 to 5 mm. wide, very acute, minutely serrulate-scabrous on the margins, otherwise smooth. Panicle branches more or less spreading, usually solitary, the lower 5 to 7 cm. long; pedicels as long as or shorter than the spikelets, rarely exceeding them, appressed. Spikelets lanceolate acute, 3 mm. long; first glume broadly lanceolate, acute, 3-nerved, scabrous on the midnerve toward the apex, two-thirds to three-fourths the length of the spikelet; second glume as long as the third glume, 5-nerved, nerves scabrous above; third glume 3 or imperfectly 5-nerved, the marginal nerves faint, indistinctly acuminate-pointed, subacute with a hyaline palea nearly three-fourths its length; flowering glume about 2 mm. long, much shorter than the second and third glumes, narrowly oblong, obtuse, with a few short hairs at the apex; palea scabrous on the keels.

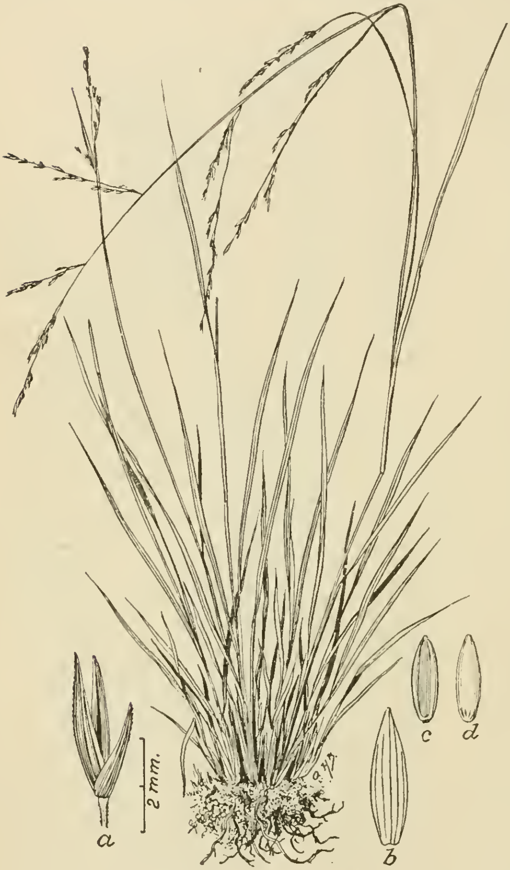

FIG. 16.—*Panicum combsii* Scribn. & Ball: *a*, spikelet; *b*, second glume; *c*, *d*, flowering glumes.

Type collected by Robert Combs, No. 583, for whom the species is named, in damp, fertile flat woods at Chipley, Washington County, Florida, August 20, 1898. A specimen, No. 571, collected August 19, in water of a cypress pond is referred here.

P. combsii belongs to the group including *P. agrostoides* Muhl. and *P. longifolium* Torr., but is separated from these by its low tufted habit, shorter, narrow leaves, long, slender spikelets, and elongated lower glume.

ARISTIDA COMBSII sp. nov. (Fig. 17.)

A tall, strict, leafy perennial, 8 to 12 dm. high, with long, rigid leaves and large compound panicles. Culms simple, terete, smooth. Sheaths longer than the internodes, smooth, striate, 1 to 1.5 dm. long, lower mostly purple; ligule a very short ring; leaf-blades linear, rigid, erect, attenuate into a long subulate point, 3 to 6 dm. long, 2 to 4 mm. wide, flat or semi-involute, smooth below, scabrous and somewhat glaucous above. Panicle large, 4 to 6 dm. long, strict or somewhat flexuous; rachis scabrous; branches long, ascending or suberect, straight or flexuous, compound, scabrous, single or in pairs, one short and few-flowered, the lower longer ones 1 to 2.5 dm. in length, naked at the base for one-fourth their length. Spikelets in pairs, one almost sessile, the other on a pedicel one-half as long as the spikelet; empty glumes lanceolate, one-nerved, 9 to 10 mm. long, including awns, subequal or the upper usually 0.5 to 1 mm. longer, scabrous on the keels or the lower all over, tipped with an awn 0.5 to 1 mm. long, longest on the lower glume; flowering glume 7 to 8 mm. long, slightly scabrous toward the apex; callus barbate, 1 mm. long; awns nearly equal, scabrous, spreading, middle awn 18 to 22 mm. long, lateral awns 16 to 20 mm. long.

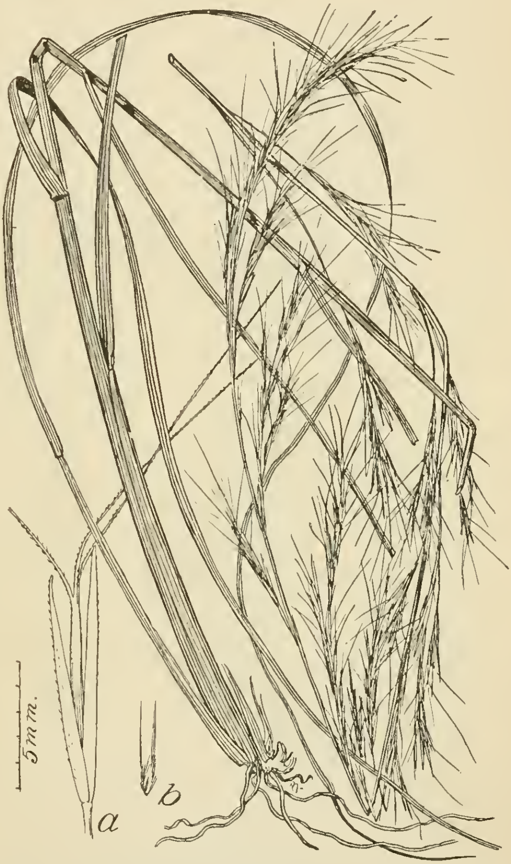

FIG. 17.—*Aristida combsii* Scribn. & Ball: *a*, spikelet; *b*, palea.

Type specimen collected by Robert Combs and C. H. Baker, No. 1069, at Grasmere, Florida, September 21, 1898.

A species with the habit and in part the appearance of *A. palustris* (Chapm.) Vasey, but with a very distinct type of inflorescence.

General distribution.—Common in high pine and blackjack lands of central peninsular Florida.

Specimens examined.—*Florida:* Bartow, Polk County, 1190 R. Combs, September, 1898; Clarcona, Orange County, 81 Marie Meislahn, October, 1899; Crystal, Citrus County, 1015 R. Combs, September, 1898; Eustis, Lake County, 1736 G. V. Nash, August, 1894; Fannin, Levy County, 869 R. Combs, September, 1898; Old Town, Lafayette County, 898*a* R. Combs, September, 1898; Tampa, Hillsboro County, 1386 R. Combs, October, 1898.

ARISTIDA INTERMEDIA sp. nov. (Fig. 18.)

A slender, somewhat geniculate, branching annual, 3 to 7 dm. high, with involute leaves and long, slender panicles. Culms smooth, freely branching, purplish, the outer branches geniculate, ascending; sheaths usually shorter than the internodes, smooth or the lower sparsely hirsute, especially on the margins, and purplish; ligule a very short ring, 0.4 mm. long or less, fringed with short hairs; blades 5 to 15 cm. long, 2 mm. wide, erect, rigid, involute, sometimes sparsely hirsute near the base. Panicle 2 to 4 dm. long, slender, often flexuose; branches short, 2 to 4 cm. long, appressed. Spikelets 8 to 10 mm. long; empty glumes narrowly lanceolate, attenuate into a rather long awn, nearly equal or the upper longer, 7 to 9 mm. long, 1-nerved, scabrous, purplish; flowering glume 7 to 9 mm. long, strongly scabrous above the middle, equaling or exceeding the empty glumes, sometimes regularly spotted as in *A. gracilis;* awns all spreading, the middle one 18 to 22 mm. long, the lateral ones 14 to 17 mm. long, all variable. This species is most closely allied to *A. gracilis*, but differs in its larger size and especially in the much longer florets and awns. It is nearly intermediate between *A. gracilis* and *A. purpurascens*, with the habit of the former and spikelets more like those of the latter.

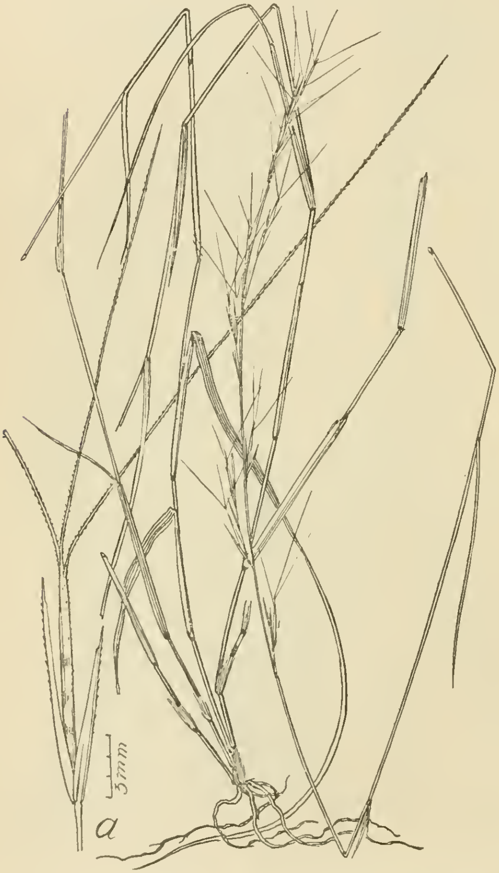

Fig. 18.—*Aristida intermedia* Scribn. & Ball: *a*, spikelet.

Type collected by T. H. Kearney, jr., No. 204, near Biloxi, Mississippi, October 5, 1896.

General distribution.—Open, dry, sandy soil, Iowa to Texas and Mississippi.

SPECIMENS EXAMINED.—*Iowa:* Wapsipinicon River, 31 E. N. Wilcox, October, 1896. *Missouri:* Courtney, 649 B. F. Bush, August, 1896. *Nebraska:* Ewing, 1075 J. M. Bates, August, 1897; Simeon, 1115 J. M. Bates, 1897. *Kansas:* Riley County, 425 A. S. Hitchcock, August, 1895. *Arkansas:* Jefferson County, 125 H. Eggert, September, 1896. *Texas:* no locality, S. B. Buckley, 1883; G. C. Nealley, 1889; J. Reverchon, F. W. Thurow. *Louisiana:* Arcadia, 78 C. R. Ball, August, 1898. *Mississippi:* Biloxi, 207, 236 T. H. Kearney, jr., October, 1896; 3774 S. M. Tracy, September, 1897; Horn Island, 1578 S. M. Tracy, September, 1891.

ARISTIDA PURPURASCENS GLAUCISSIMA Kearn. var. nov.

Whole plant very glaucous, otherwise like typical *A. purpurascens.* Conspicuous in the field on account of its bluish-white color.

Type collected by T. H. Kearney, jr., No. 321, in very dry, sterile soil in an opening in the pine forest, 6 miles above Biloxi, Mississippi, October 7, 1896.

TRIODIA SESLERIOIDES ARISTATA var. nov.

A robust grass, 12 to 18 dm. high. Panicle large, open, its lower branches 2 to 2.5 dm. long; excurrent tips of the nerves in the flowering glume 1 to 1.5 mm. long.

Type collected by Miss Marie Meislahn, No. 90, at Clarcona, Orange County, Florida, October (?), 1899.

GENERAL DISTRIBUTION.—Not uncommon in low, open woods of central Florida.

SPECIMENS EXAMINED.—*Florida:* Grasmere, 1135 R. Combs and C. H. Baker, September, 1898; Homosassa, 978 R. Combs, September, 1898; McDonald, 132 C. H. Baker, October, 1898; Oakwood, Duval County, 322 A. Fredholm, October, 1893; Ormond, 5562 A. H. Curtiss, September, 1895.

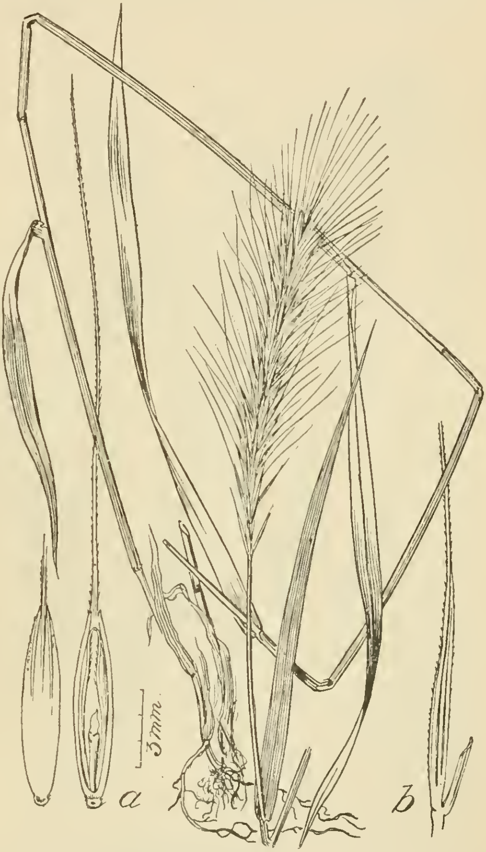

FIG. 19.—*Elymus arkansanus* Scribn. & Ball: *a*, dorsal and anterior views of the flowering glume; *b*, empty glumes.

ELYMUS ARKANSANUS sp. nov. (Fig. 19.)

A slender, erect perennial, with a short, broad, bristly, nodding spike. Culms 6 to 8 dm. high, terete, smooth; nodes smooth; sheaths mostly a little shorter than the internodes, ciliate on the margins or the lower sparsely hirsute-pubescent; ligule less than 1 mm. long, membranaceous; leaf-blades 1 to 2 dm. long, 5 to 8 mm. wide, narrowly lanceolate-acuminate, erect or ascending, auricled at the base, scabrous below and on the margins, finely and densely pubescent above.

Spike long-exserted on the slender pedicel, nodding, 6 to 9 cm. long; internodes of the rachis angular, somewhat compressed, hispid-ciliate on the margins, 3 to 4 mm. long. Spikelets 2 at each joint, 2-flowered, the upper very small; empty glumes divergent, linear-subulate, cylindrical and coriaceous at base, flattened, scabrous, and 2 or 3 nerved above, 8 to 10 mm. long, or, including the stout, straight, scabrous awn, 2 to 3 cm. long; flowering glume narrowly lanceolate, acute, raised on a short stipe and separating from it by a horizontal constriction, minutely scabrous, 3 to 5 nerved at apex, 7 mm. long, terminating in a straight, slender, scabrous awn 2 to 4 cm. long. Palea slightly shorter than its glume, rounded or slightly bidentate at apex, hispid on the keels above.

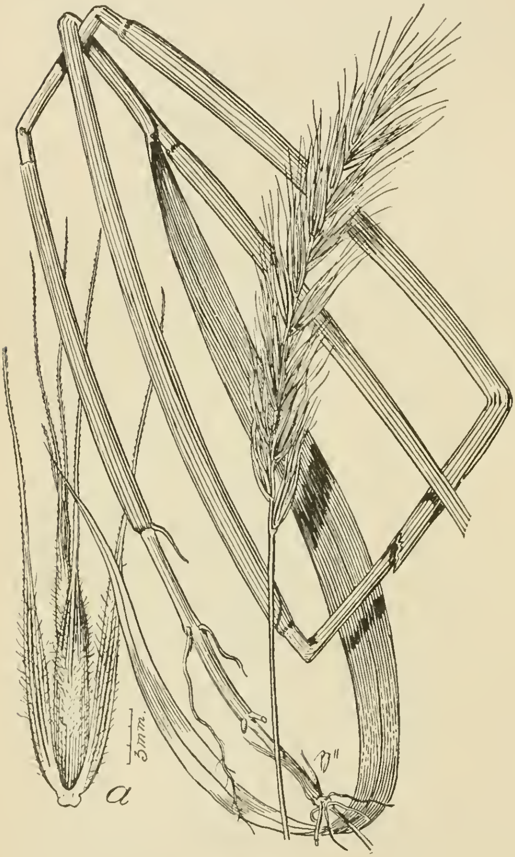

FIG. 20.—*Elymus australis* Scribn. & Ball: *a*, a single spikelet, showing hairy glumes.

E. arkansanus is allied to *E. striatus*, from which it is distinguished by having the empty and flowering glumes minutely scabrous instead of hirsute.

Type collected by F. L. Harvey (Arkansas Flora 7, in part) in woods of northwestern Arkansas. The same sheet bears also a specimen of *E. striatus*.

SPECIMENS EXAMINED.—*Arkansas:* Fort Smith, Dr. J. M. Bigelow, in Whipple's Exploration, 1853–1855. *Missouri:* Springfield, S. A. Hoover, 1897. *Iowa:* Nodaway River, Adair County, F. C. Stewart, July, 1892 (Herb. Iowa State College).

ELYMUS AUSTRALIS

sp. nov. (Fig. 20.)

A tall, stout perennial with broad leaves and a large bristly spike. Culms erect, 9 to 14 dm. high, terete, smooth; nodes smooth; sheaths scabrous-hirsute, especially on the margins, longer or shorter than the internodes, the upper ones smooth and somewhat inflated; ligule a mere ring less than 0.5 mm. long, entire; leaf-blades ascending, 2 to 3 dm. long, 1 to 1.5 cm. wide, acuminate, strongly scabrous below, scabrous or scabrous-hirsute above. Spike robust, bristly, 1 to 1.3 dm. long, the peduncle exserted, 0.5 to 1.5 dm.; rachis angular, compressed, scabrous-pubescent on the margins and on the back above. Spikelets 2 at each node, 4 to 5 flowered; empty glumes divergent, thickened, coriaceous and somewhat curved at the base, 5-nerved above, scabrous-hirsute or rarely nearly smooth, about 1.5 cm. long, tipped with a short, straight awn of equal length; flowering glume borne on a stout stipe, lanceolate, 8 to 10 mm.

long, hirsute, tipped with a short, straight, scabrous awn 2.5 to 3 cm. long. Palea a little shorter than its glume, obtuse or minutely bidentate, scabrous between the keels.

This species has heretofore been referred to *E. canadensis* L., *E. virginicus* L., *E. striatus* Willd., and *E. hirsutiglumis* Scribn. From the first it is distinguished by the thickened, hirsute, empty glumes; from *E. virginicus* L. by its hirsute spikelets and longer awns; from *E. striatus* Willd. by more robust culms and spikes and by the thickened 5-nerved empty glumes, while it may be separated from *E. hirsutiglumis* Scribn., its nearest ally, by its more robust spikes and longer glumes and awns.

Type from Biltmore Herbarium, No. 411*b*, collected on banks of streams at Biltmore, North Carolina, July 7, 1897.

General distribution.—Moist woods and thickets from North Carolina and Florida west to Arkansas and Missouri.

Specimens examined.—*Florida:* no locality, A. H. Curtiss, 1886. *Alabama:* Valley Head, 38 A. Ruth, July, 1898. *Georgia:* Augusta, 222 T. H. Kearney, jr., July, 1895; Luluh Falls, Lookout Mountain, 16 A. Ruth, 1898. *Arkansas:* White River, near Batesville, F. V. Coville, August 2, 1887. *Missouri:* St. Louis, 195 H. Eggert, July, 1879. *Illinois:* no locality, J. Wolf, 1882.

ELYMUS BRACHYSTACHYS sp. nov. (Fig. 21.) (*Elymus canadensis glabriflorus* Vasey, Contr. U. S. Nat. Herb. **2**: 550 (1894) (in part).)

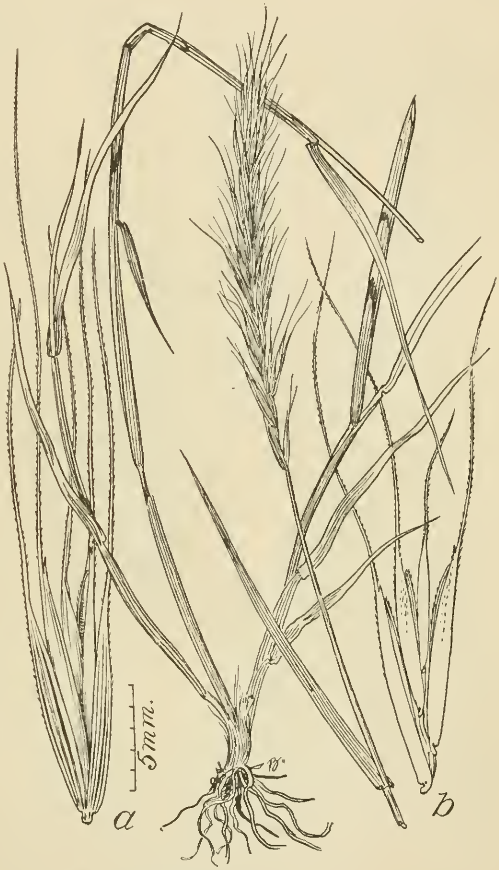

Fig. 21.—*Elymus brachystachys* Scribn. & Ball: *a*, a single spikelet; *b*, the same with the outer glumes removed.

A low but rather stout perennial with bristly nodding spikes. Culms 3 to 9 dm. high, erect or somewhat geniculate at base, smooth, terete; nodes smooth; sheaths mostly shorter than the internodes, smooth, striate; ligule a short, entire ring, less than 1 mm. long; leaf-blades 1 to 2 dm. long, 6 to 11 mm. wide, acuminate, ascending, semi-involute, smooth or somewhat scabrous below, finely scabrous above and on the margins. Spike rather dense, 8 to 15 cm. long, long-exserted on a stout peduncle; rachis thickened, striate, 4-angled or more compressed and 2-angled, entirely smooth or scabrous on the angles. Spikelets glabrous, 2 at each joint, 3 to 5 flowered; empty glumes flat, scabrous, 8 to 10 mm. long or with the straight scabrous awn 2.5 to 3.5 cm. long, 1 mm.

wide, 3 or rarely 5 nerved; flowering glume smooth or minutely scabrous, borne on a short stipe, 11 to 13 mm. long, 5-nerved, the nerves next the keel often shortly excurrent, tipped with a straight or sometimes divergent scabrous awn 2 to 4 cm. in length. Palea about 10 mm. long, narrow, tapering to a narrow, truncate, or minutely bidentate point, scabrous on the keels.

Closely allied to *E. canadensis* L., but easily distinguished by its smaller size and the scabrous but not hirsute flowering glumes.

General distribution.—Moist, open or somewhat shaded ground, from Michigan and South Dakota south to Texas, New Mexico, and into Mexico.

Type specimen collected by Dr. Edward Palmer, No. 420, "in the Indian Territory, chiefly on the False Washita, between Fort Cobb and Fort Arbuckle, 1868."

Specimens examined. — *Michigan:* "Southern Michigan," 1409 O. A. Farwell, August, 1893. *Iowa:* Several specimens in Herb. Iowa State College from western and northern Iowa. *South Dakota:* Hot Springs, 1173, 1174 P. A. Rydberg, August, 1892. *Colorado:* Colorado Springs, 734 C. L. Shear, July, 1896; Walsenburg, Huerfano County, 778 C. L. Shear, July, 1896; Chase, Park County, 1101 C. L. Shear, September, 1896; "along Burl. and Mo. R. Ry.," L. H. Pammel, July, 1896. *Kansas:* Manhattan, W. A. Kellerman, July, 1888; Osborne, 709 C. L. Shear, June, 1896; Syracuse, 135 C. H. Thompson, July, 1893. *Texas:* Austin, 34 E. N. Plank, July, 1892; Kerrville, J. G. Smith, June, 1897; no locality, 571 F. Lindheimer, 1846. *New Mexico:* 2075 C. Wright, 1851–52. *Mexico:* Saltillo, Coahuila, 260 Dr. E. Palmer, June, 1898.

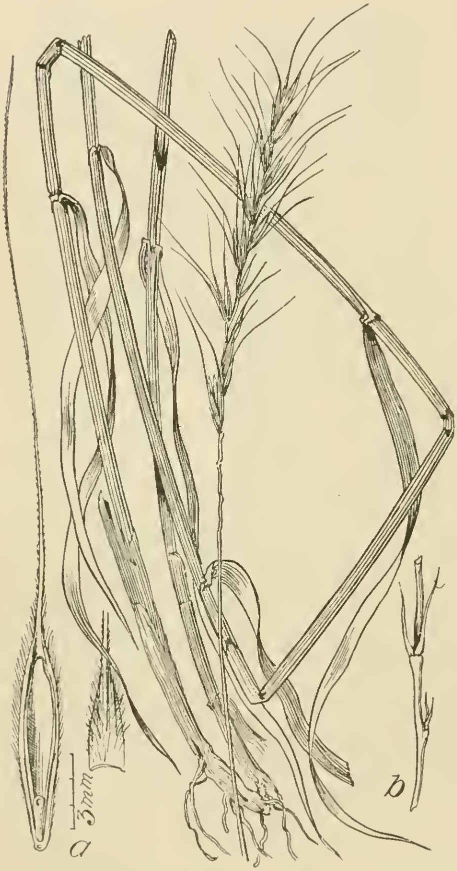

Fig. 22.—*Elymus diversiglumis*, Scribn. & Ball: *a*, anterior view of a floret and dorsal view of apex of a flowering glume.

ELYMUS DIVERSIGLUMIS

sp. nov. (Fig. 22.)

A rather stout, erect perennial, 9 to 12 dm. high, with a slender, flexuous spike 1 to 1.5 cm. long, and the empty glumes reduced or nearly wanting. Culms terete, glabrous; nodes glabrous; sheaths glabrous, striate, nearly equaling or longer than the internodes; ligule membranaceous, less than 2 mm. long; leaf-blades spreading, 1.5 to 2.5 cm. long, 6 to 12 mm. wide, tapering to a long-acuminate point, scabrous on both surfaces and the margins; rachis rather slender, compressed, smooth or scabrous-ciliate on the edges and upper part of each internode. Spikelets in pairs, 2-flowered; empty glumes subulate, scabrous, varying from a mere point to 1.5 cm. in length in the same spikelet; flowering glumes, on a short stipe, linear-lanceolate, acute, 8 to 10 mm. long, indistinctly 3 to 5 nerved, scabrous and thinly hirsute, tipped with a stout, divergent, scabrous awn, 2 to 3 cm. long. Palea equaling or slightly shorter than the glume, bidentate, minutely scabrous.

This species is closely allied to *E. canadensis*, but is readily distinguished by the more slender, open infloresence and the unequal and much reduced empty glumes.

Type collected by T. A. Williams, No. 2653, in rich openings of the Bear Lodge Mountains, Wyoming, July 23, 1897, altitude 6,000 feet.

SPECIMENS EXAMINED.—*Wisconsin:* No locality, F. F. Wood. *North Dakota:* Turtle Mountains, Bottineau County, 85 M. A. Brannon, July, 1896; Langdon, 150 M. A. Brannon, July, 1896. *Wyoming:* Welcome, 2679, 2681 T. A. Williams, July, 1897.

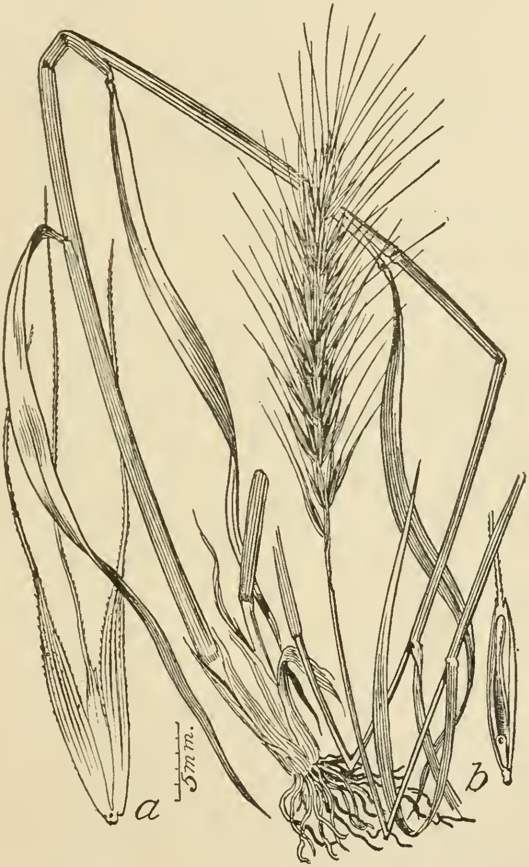

FIG. 23.—*Elymus glabriflorus* (Vas.) Scribn. & Ball: *a*, a single spikelet, showing the outer glumes; *b*, anterior view of a floret.

ELYMUS GLABRIFLORUS (Vasey) n. comb. (*E. canadensis* var. *glabriflorus* Vasey, in Dewey, Contr. U. S. Nat. Herb. **2**: 550 (1894).) (Fig. 23.)

A tall, stout, leafy perennial with large leaves and long, dense spike. Culms stout, erect, 6 to 10 dm. high, smooth, terete; nodes smooth; sheaths crowded, longer than the internodes, smooth or rough-hirsute, loose; ligule less than 1 mm. long, entire; leaf-blades numerous, 1.5 to 3 dm. long, 7 to 10 mm. wide, flat or partially involute, erect or ascending, somewhat scabrous below, scabrous on the margins and scabrous and sometimes sparsely hirsute above; spike robust, erect or nodding, 1 to 1.5 dm. long, often glaucous; rachis thick, somewhat compressed, smooth or ciliate, scabrous on the margins. Spikelets 2 to 3 at each node, 3 or 5 flowered; empty glumes thickened, coriaceous and somewhat curved at the base, strongly 3 to 5 nerved, scabrous on the nerves and often ciliate-scabrous on the margins, 11 to 15 mm. long, or with the straight, scabrous awn 3 to 3.5 cm.; flowering glumes on a short stipe, 9 to 12 mm. long, minutely scabrous, tipped with a straight, slender, scabrous awn 2 to 3 cm. long. Palea 8 to 10 mm. long, scabrous on the keels, truncate or minutely bidentate.

This species is more closely allied to *E. australis*, of which it is a glabrous-flowered counterpart, than to *E. canadensis*, from which it is distinguished by the heavier spikes, thickened empty glumes, and merely scabrous flowering glumes, while these first two characters serve to separate it from *E. brachystachys*. It seems unfortunate that this plant should have received the name *E. canadensis glabriflorus* when *E. brachystachys* really stands in that relationship to *E. canadensis*.

Type specimen collected in low, miry, even saltish places at Pointe-à-la-Hache, Louisiana, by A. B. Langlois, No. 81, June, 1885.

GENERAL DISTRIBUTION—Low, rich woods or thickets from Pennsylvania and Georgia to Tennessee and New Mexico.

SPECIMENS EXAMINED.—*Pennsylvania:* Easton, T. C. Porter, August 13, 1897; Philadelphia, 47 C. E. Smith, August. *District of Columbia:* Tennallytown. *Maryland:* Glen Echo, 15 T. H. Kearney, jr., August, 1894; Hamilton Hill, 701 C. R. Ball, July, 1900. *Virginia:* Norfolk, 293 T. H. Kearney, jr., August, 1895; Portsmouth, 36, 37 Noyes, 1895. *North Carolina:* Columbus, E. C. Townsend, 1897. *South Carolina:* Florence, 686 C. R. Ball, August, 1900. *Georgia:* Banks of the Coosa, mountains of Georgia, 23 A. W. Chapman, 1883. *Tennessee:* Cowan, 23 A. Ruth, July, 1898. *Alabama:* De Kalb County, 6 H. Eggert, June, 1897; Nesheka, 9 G. W. Carver, July, 1897. *Louisiana:* Arcadia, 84 C. R. Ball, August, 1898; Pointe-à-la-Hache, 81 A. B. Langlois (type). *Texas:* Ennis, J. G. Smith, July, 1898; no locality, G. C. Nealley, 1886; F. W. Thurow, 1889. *New Mexico:* 2073 C. Wright, 1851–52.

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U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[**Grass and Forage Plant Investigations.**]

FIELD WORK OF THE DIVISION OF AGROSTOLOGY:

A REVIEW AND SUMMARY OF THE WORK DONE SINCE THE ORGANIZATION OF THE DIVISION, JULY 1, 1895.

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BY

CORNELIUS L. SHEAR,
Assistant Agrostologist.

PREPARED UNDER THE DIRECTION OF F. LAMSON-SCRIBNER, AGROSTOLOGIST.

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PREPARED UNDER THE DIRECTION OF F. LAMSON-SCRIBNER, AGROSTOLOGIST.

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LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Division of Agrostology,
Washington, D. C., June 15, 1901.

Sir: I have the honor to transmit herewith the manuscript of a report on the "Field Work of the Division of Agrostology," by Cornelius L. Shear, assistant in this Division in charge of seed and field work, and to recommend its publication as Bulletin No. 25 of this Division. This report is a comprehensive statement of the work done in the field by the Division of Agrostology since its organization July 1, 1895, together with a summary of the results accomplished in the way of new discoveries and the development of useful species of grasses and forage plants.

Respectfully,

F. Lamson-Scribner,
Agrostologist.

Hon. James Wilson,
Secretary of Agriculture.

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FIELD WORK OF THE DIVISION OF AGROSTOLOGY: A REVIEW AND SUMMARY OF THE WORK DONE SINCE THE ORGANIZATION OF THE DIVISION, JULY 1, 1895.

INTRODUCTION.

The Division of Agrostology was established by Congress in 1895 for the purpose of investigating the various problems relating to the grasses and forage plants of the United States. Progressive farmers, stockmen, and dairymen had for some time recognized that there was urgent need of a thorough study of the various forage problems which were presenting themselves in different parts of the country. Consequently the then Secretary of Agriculture, Hon. J. Sterling Morton, recommended to Congress that a separate Division be established to take charge of and prosecute the work. The rapidly deteriorating condition of the native meadows and ranges of the great West naturally led the stockmen to inquire into the reasons for these conditions, and to try to ascertain what steps might be taken to improve them. The very rapid development of the stock-growing industry in the West, which immediately followed the building of the transcontinental railroads, brought about increasing competition for the use of the grazing lands, and under the mistaken impression that the abundant forage at first found was practically inexhaustible, together with the effort on the part of each to secure as much advantage as possible from the "free grass," great injury naturally resulted to the grazing lands.

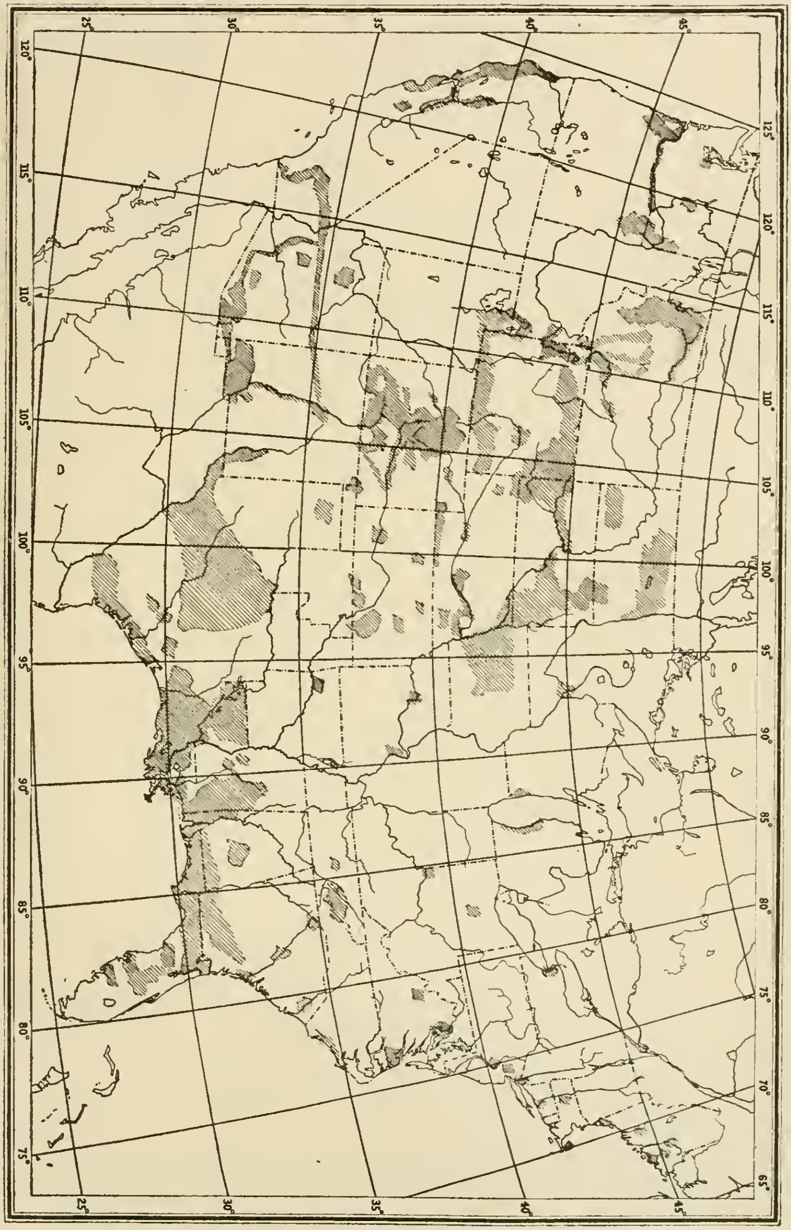
The stock-growing industry is one of great importance and one that should be carefully fostered. The vast areas of land throughout the Western States and Territories, which are at present unavailable for general agricultural purposes, and the greater part of which probably never will be available for such use on account of the insufficient water supply, should be properly controlled so as to conserve their usefulness.

Of the unoccupied public lands about 365,400,000 acres are regarded at present as fit only for grazing purposes. There are, in addition, 124,300,000 acres of forest land, the greater portion of which is also used for grazing. The various evils arising from overstocking and denuding extensive areas of grazing and timber lands bear such a direct relation to the general welfare of the whole West that it is incumbent upon the General Government to make a thorough investigation of all the questions involved and if possible devise some means of remedying the present conditions. The relation of the grazing industry to forest reserves, to the water supply, to erosion, and the various other matters to which it more or less directly relates can not be solved except by long and careful investigation of the actual facts and conditions prevailing. While the problems presented by the vast semiarid grazing regions of the West seemed most urgent, there were also important questions in the other portions of the country pressing for solution. The questions involved required, first of all, a thorough and accurate knowledge of the actual facts and conditions existing. Thus, field work was commenced as soon as the Division was established in order that the necessary data might be secured as a basis for future work and recommendations.

PERSONS ENGAGED AND TERRITORY COVERED.

The field work of the Division has been carried on by different members of the regular office force and by special agents employed for certain periods during the summer season. Twenty-seven persons in all have been engaged at different times in the work. The following is a list of those who have done field work, with the names of the States or Territories in which such work has been done:

C. R. Ball, 1898, 1900, 1901	Alabama, Louisiana, Mississippi, South Carolina.
E. A. Bessey, 1898	Colorado.
M. A. Brannon, 1896	North Dakota.
Edw. R. Chase, 1895	Utah.
F. E. Clements, 1896	Colorado.
R. Combs, 1898	Florida.
J. B. Davy, 1899	California.
C. J. Elmore, 1896	Nebraska.
C. C. Georgeson, 1898	Texas.
David Griffiths, 1896–97	Arizona, Montana, South Dakota, Wyoming.
T. H. Kearney, 1895	Alabama, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia.
Emil F. Lange, 1900	Montana.
A. B. Leckenby, 1898–1900	Washington, Oregon.
E. D. Merrill, 1900	Idaho, Minnesota, Montana, Wisconsin, Wyoming.
Aven Nelson, 1897	Wyoming.
Elias Nelson, 1900	Wyoming.
C. R. Orcutt, 1896	Arizona, California, New Mexico, Texas.
L. H. Pammel, 1896	Colorado, Iowa, Nebraska, South Dakota, Wyoming.
P. A. Rydberg, 1895–96	Colorado, Idaho, Montana, Nebraska, Utah, Wyoming.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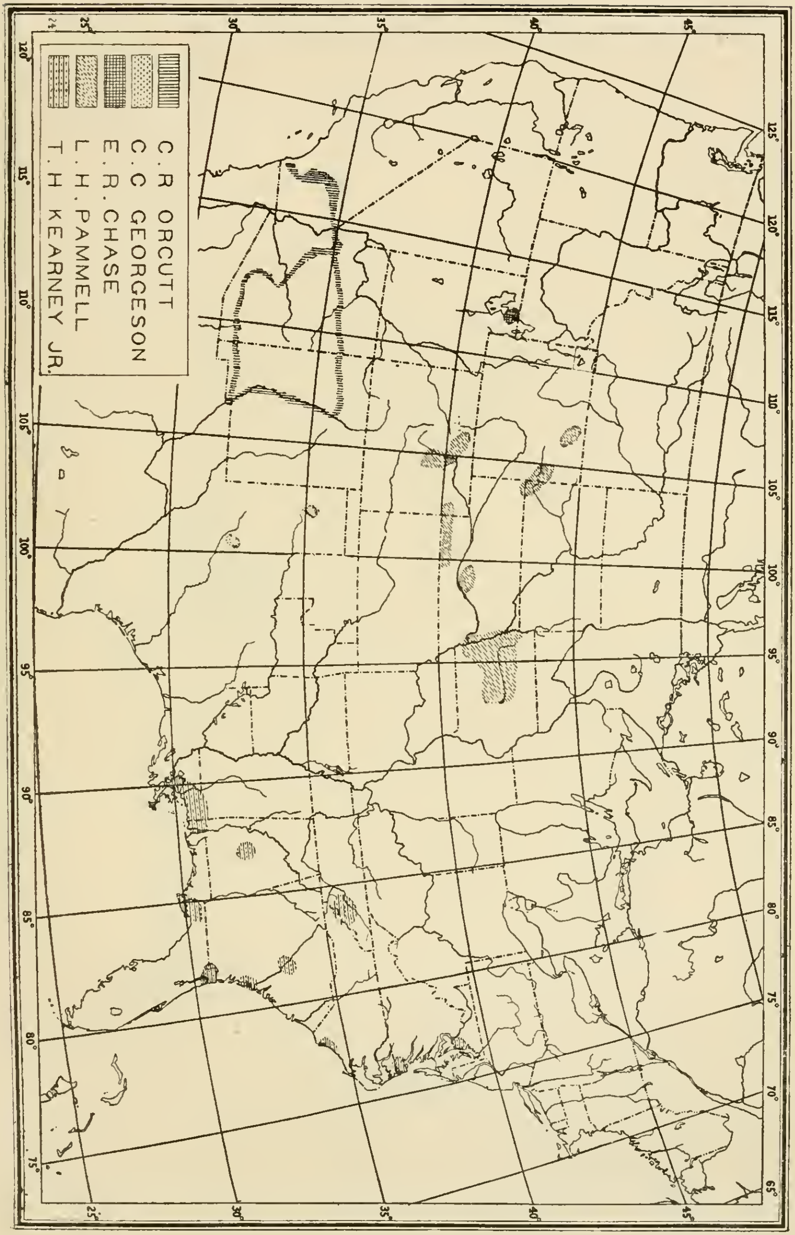
TOTAL TERRITORY COVERED BY THE FIELD WORK OF THE DIVISION OF AGROSTOLOGY, 1895-1900.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C. C. GEORGESON
E. R. CHASE
L. H. PAMMELL
T. H. KEARNEY JR.
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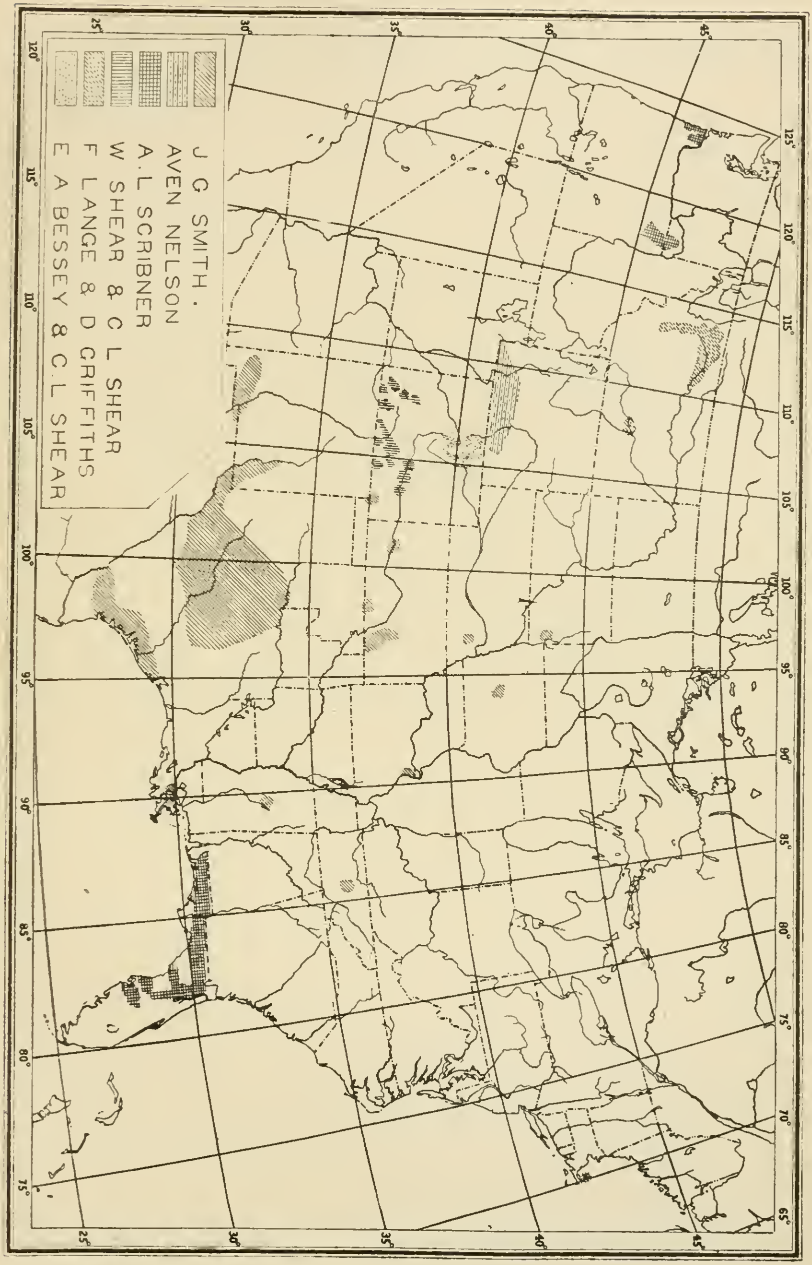
FIELD WORK OF THE DIVISION OF AGROSTOLOGY.

MAP 3.


J G SMITH.
AVEN NELSON
A. L SCRIBNER
W SHEAR & C L SHEAR
F LANGE & D GRIFFITHS
E A BESSEY & C. L SHEAR
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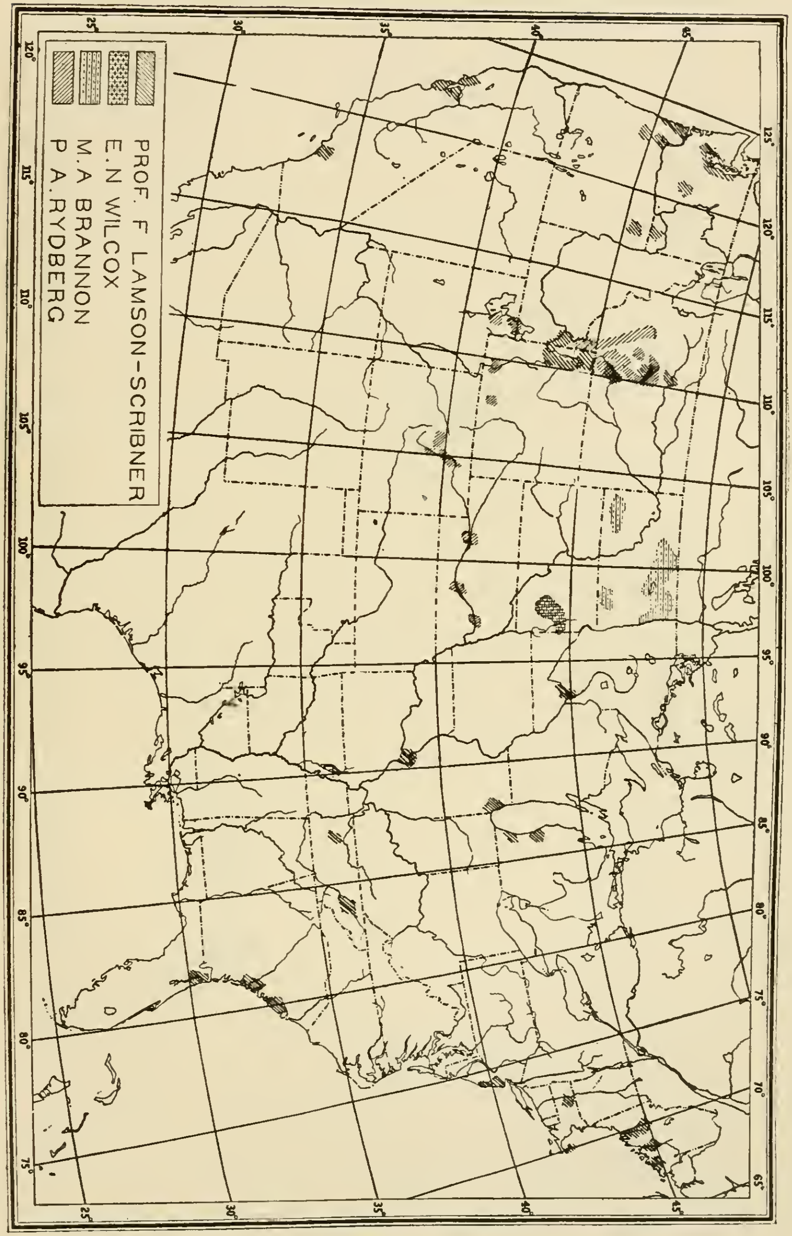
FIELD WORK OF THE DIVISION OF AGROSTOLOGY.

MAP 4.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M. A BRANNON
P A. RYDBERG
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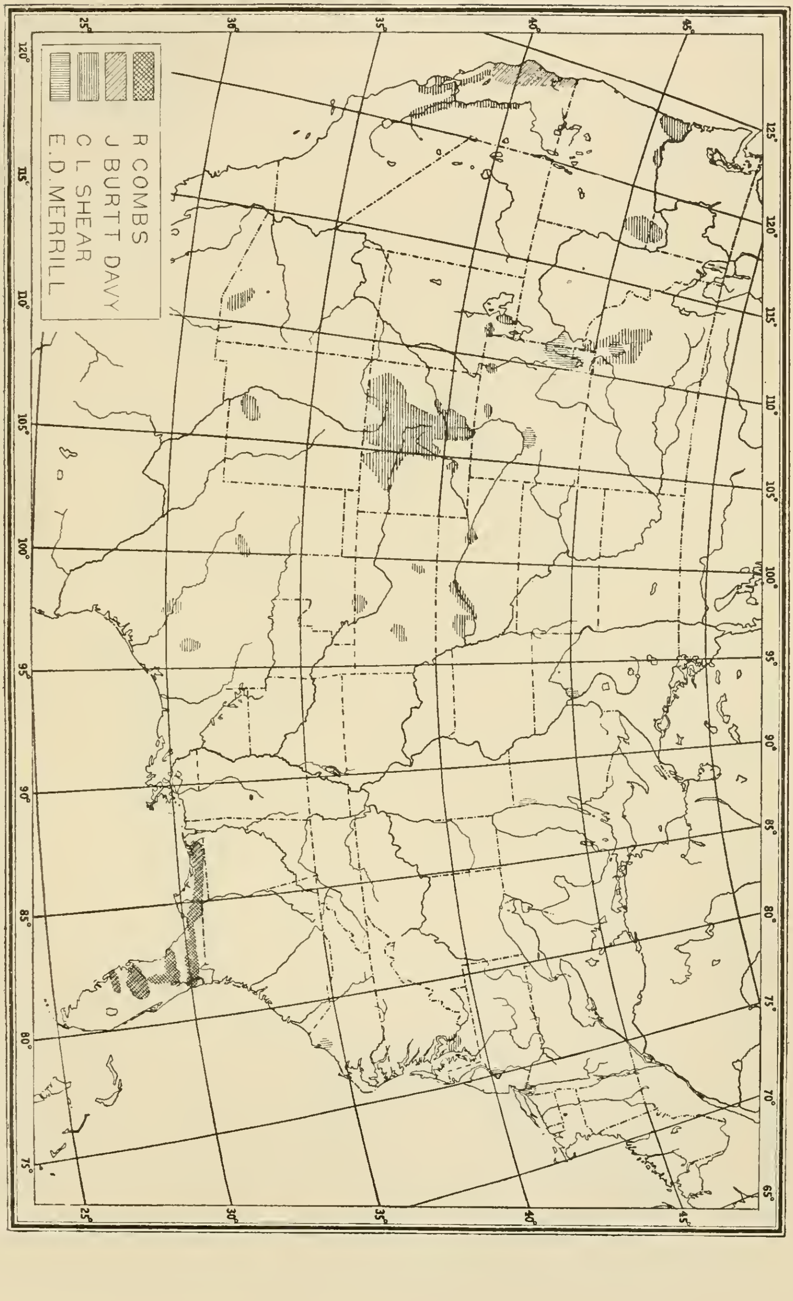
FIELD WORK OF THE DIVISION OF AGROSTOLOGY.

MAP 5.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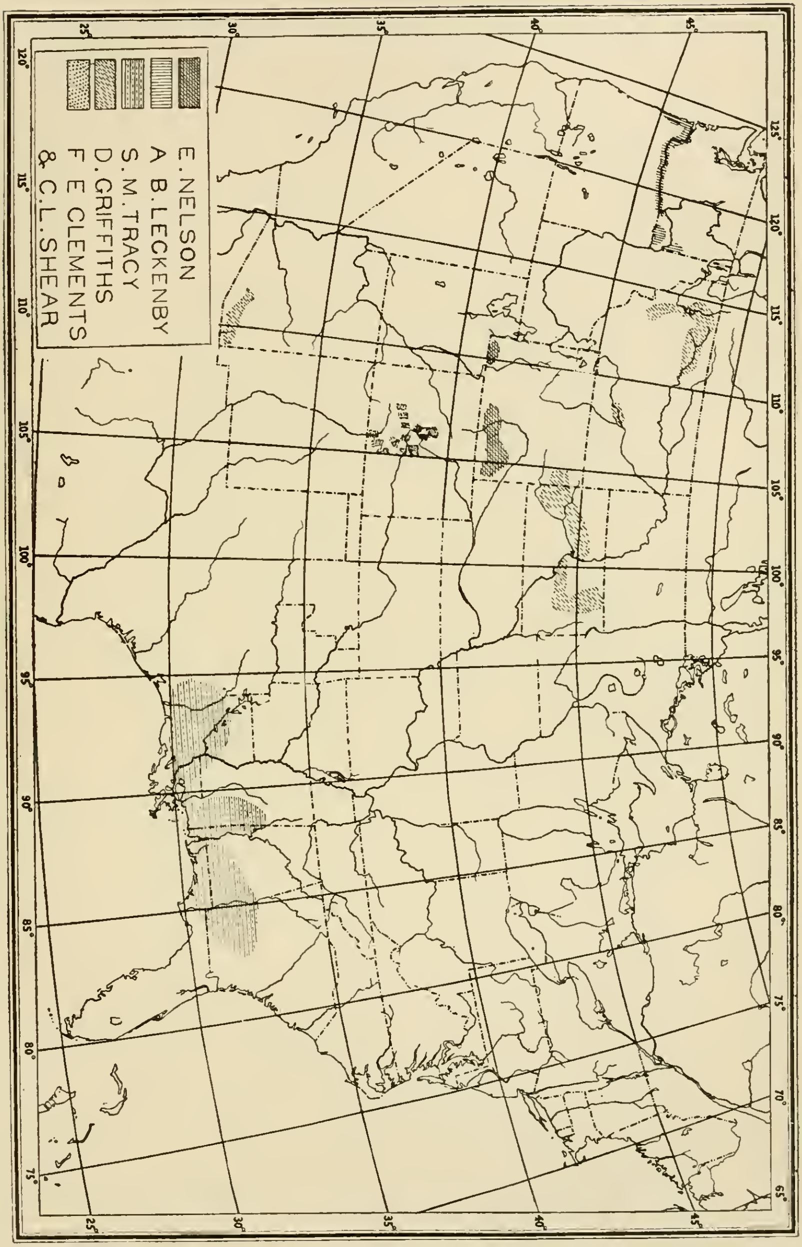
E. NELSON
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S. M. TRACY
D. GRIFFITHS
F E CLEMENTS & C. L. SHEAR
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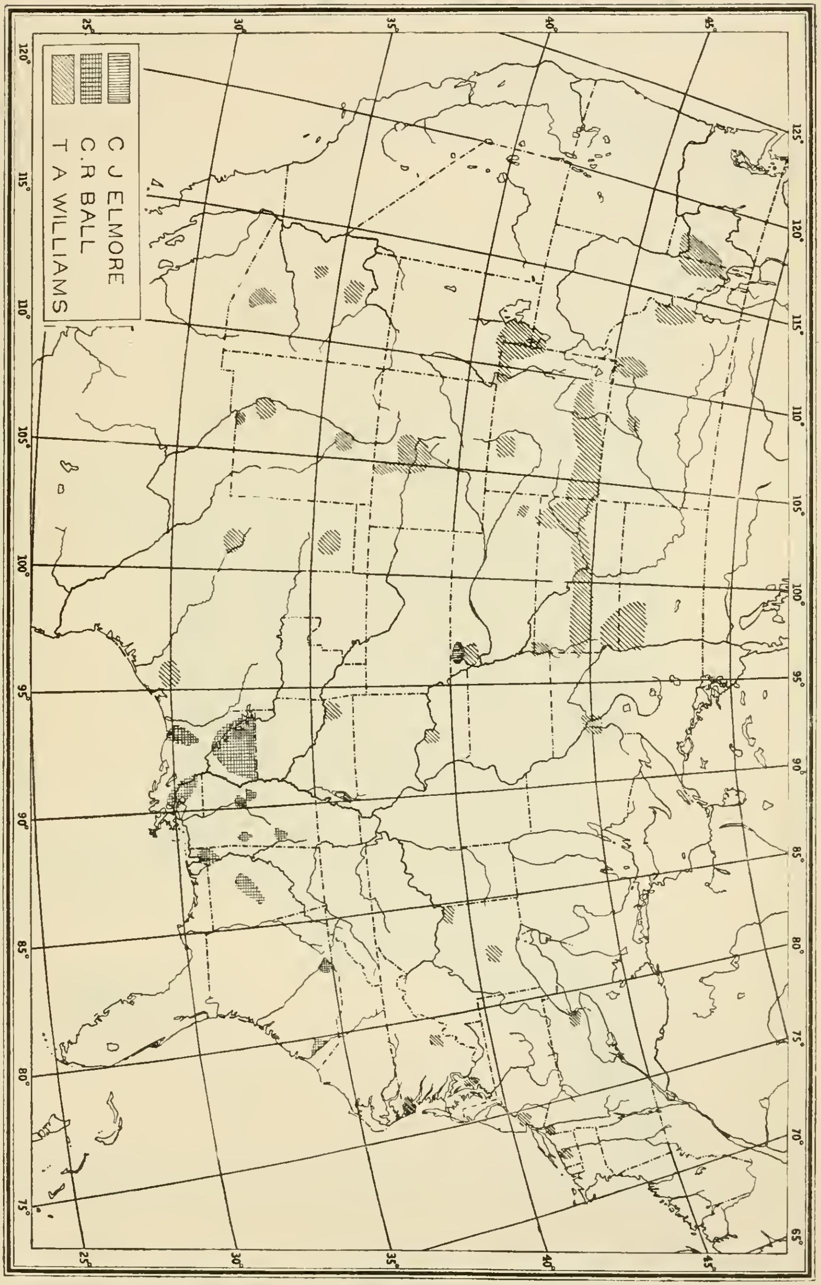
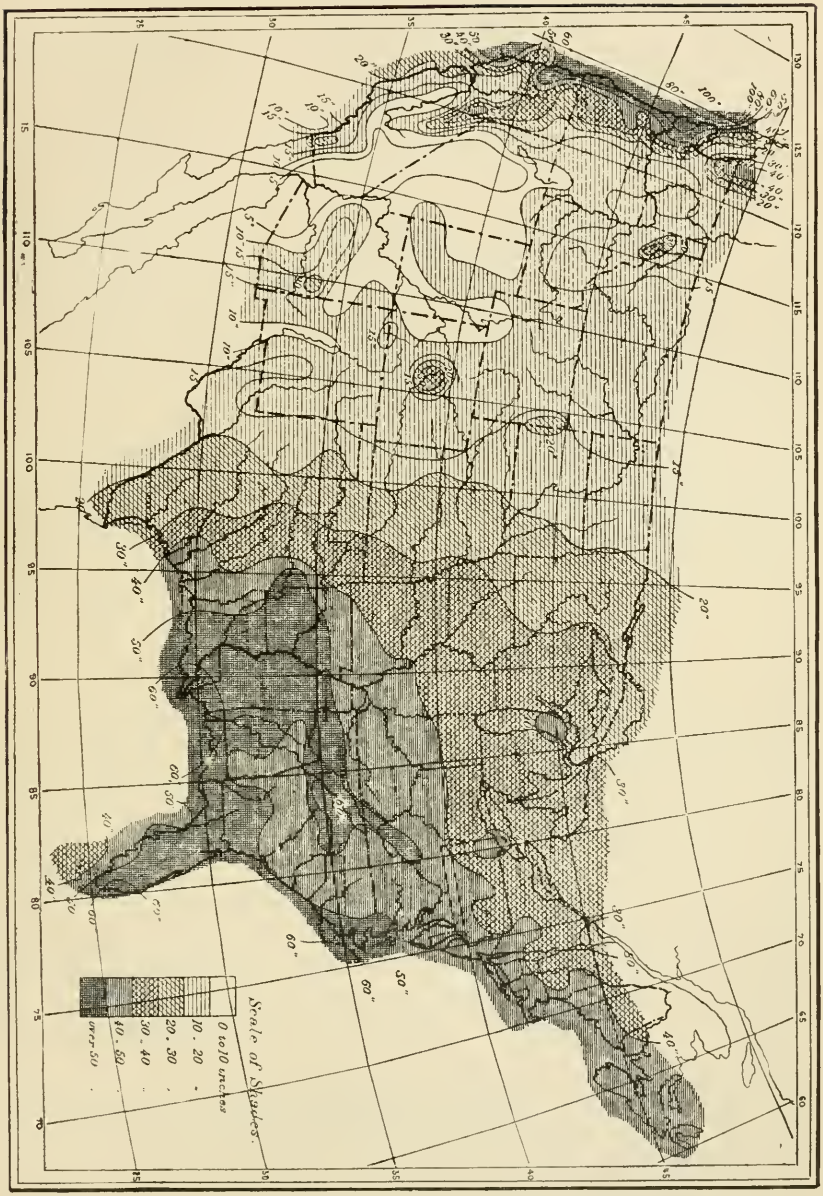

C J ELMORE
C.R BALL
T A WILLIAMS

FIELD WORK OF THE DIVISION OF AGROSTOLOGY.


Scale of Shades.
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10. 20 "
20. 30 "
30. 40 "
40. 50 "
over 50 "
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15"
20"
30"
40"
50"
60"
80"
100"

AMOUNT AND DISTRIBUTION OF THE ANNUAL PRECIPITATION. (AFTER WEATHER BUREAU CHART.)

F. Lamson-Scribner, 1896–1900	California, Florida, Idaho, Maine, Massachusetts, Michigan, Oregon, South Carolina, Washington, Wyoming.
A. Lamson-Scribner, 1900	Florida, Massachusetts, Oregon, Washington.
C. L. Shear, 1895–1901	Arizona, California, Colorado, Idaho, Kansas, Maryland, Montana, Nebraska, New Mexico, Oregon, Texas, Utah, Washington, Wyoming.
J. C. Smith, 1895–1898	Colorado, Iowa, Kansas, Louisiana, Mississippi, Missouri, Nebraska, New Mexico, South Dakota, Tennessee, Texas.
William Shear, 1900	Colorado.
S. M. Tracy, 1897	Alabama, Florida, Georgia, Louisiana, Mississippi, Texas.
E. N. Wilcox, 1897	South Dakota.
T. A. Williams, 1896–1900	Arizona, Arkansas, Colorado, Connecticut, Idaho, Maryland, Minnesota, Missouri, Montana, New Jersey, New Mexico, New York, North Dakota, Ohio, South Dakota, Texas, Utah, Virginia, Washington, Wyoming.

It will be observed from this list that the greatest amount of work has been done in the South, on the Great Plains, and in the Rocky Mountain region. The work in these regions was naturally undertaken first on account of our insufficient knowledge of the forage plants and conditions and on account of the great importance of the forage problems in these regions.

PREVIOUS INVESTIGATIONS.

At the beginning of the investigations by the Division exact knowledge of the grasses and forage plants of the greater part of the range lands of the country west of the Mississippi River was very limited. Some field work had been done in certain portions of the West under the direction of Dr. George Vasey, former botanist of the Department of Agriculture. The various Government surveying parties had made collections of more or less importance at various places, and a few private collectors had also done considerable work in this direction.[1] The greater part of this work, however, had been devoted to the collection of the plants found, without giving special attention to the relative value and importance of the species as forage.

PRINCIPAL PROBLEMS AND REQUIREMENTS AT THE BEGINNING OF THE WORK.

While the purely botanical explorations of this part of the country had afforded material for a catalogue of most of our grasses, yet very little was known of their distribution, abundance, and relative value for forage purposes. It was quite essential that accurate knowledge should be secured in regard to these matters and that field investigations should be undertaken with this particular end in view. Conflicting accounts had been received from stockmen and ranchmen with regard to the different grasses, their value, abundance, and distribution. Unfortunately reports from such sources can not always be relied upon, as the parties making them have rarely had sufficient training in accurate observation and comparison of plants to arrive at correct conclusions. The grasses are so numerous and the characteristics distinguishing the species are in many cases so inconspicuous that only the trained agrostologist can distinguish them. Another liability to confusion results from lack of uniformity in the application of the common names of grasses.

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[1] See preface to Bull 16, Div. Agrost. for further account of work previous to the establishment of this Division.

Another question of great importance was the actual condition of the pasture and range lands and the causes which have led to their present condition. The conditions vary greatly in different places, so that only by actual inspection of the greater portion of the range lands could a just estimate be made. The fact that, as a general thing, the ranges were becoming impaired was generally admitted, but to just what extent, and as a result of what causes, it was very important to accurately ascertain. Some were disposed to account for it largely on the supposition that there was less annual precipitation than formerly. The validity of this statement was easily determined, however, by reference to the Weather Bureau records, which, though in some cases not extending over a sufficient number of years to determine the question with absolute certainty, yet were sufficient to indicate that there was not enough, if any, decrease in the average rainfall to account for the great deterioration of the range lands. The effectiveness of the rainfall, however, is much less at present than formerly, but this is the result of the present condition of the ranges rather than its cause, and involves the question of the effect of overgrazing upon the conservation of the water supply and upon erosion—questions of great importance, which demand careful and thorough investigation. Whereas overgrazing was generally admitted to be the fundamental cause of most of the trouble, it was important to learn exactly to what extent the ranges were being overstocked and the exact manner in which the resulting injury occurs.

Field workers were instructed to make a thorough investigation of all the matters above referred to by a careful examination of the ranges and meadows and also by inquiry from stockmen and ranchmen. They were also instructed to make collections of all the native grasses and forage plants with full notes regarding their forage value, abundance, past and present distribution, and also to collect seeds of all the valuable species, particularly those giving indications of usefulness under cultivation. In cases where seed could not be secured

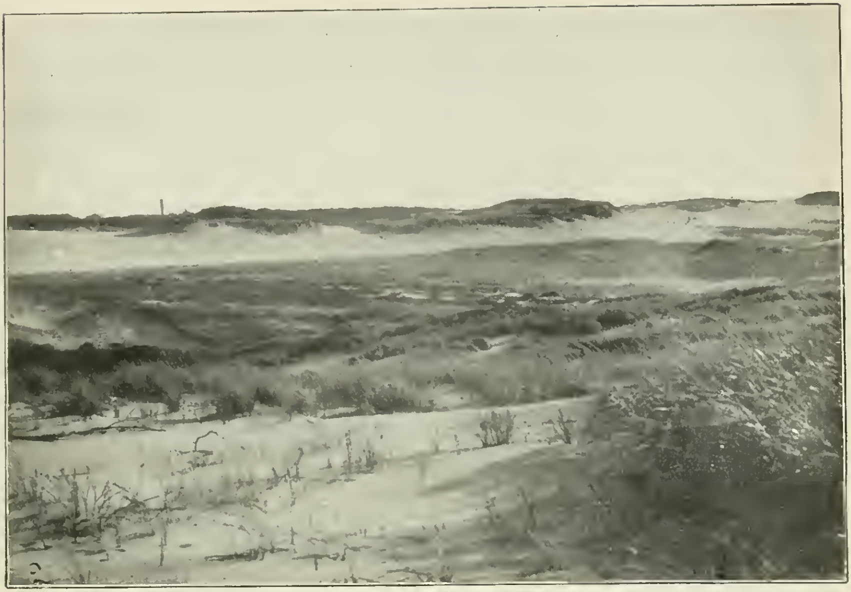


FIG. 1.—VIEW AT CAPE COD, MASS., SHOWING SAND DUNES AND GENERAL APPEARANCE OF THE COUNTRY.

From a photograph by F. Lamson-Scribner.

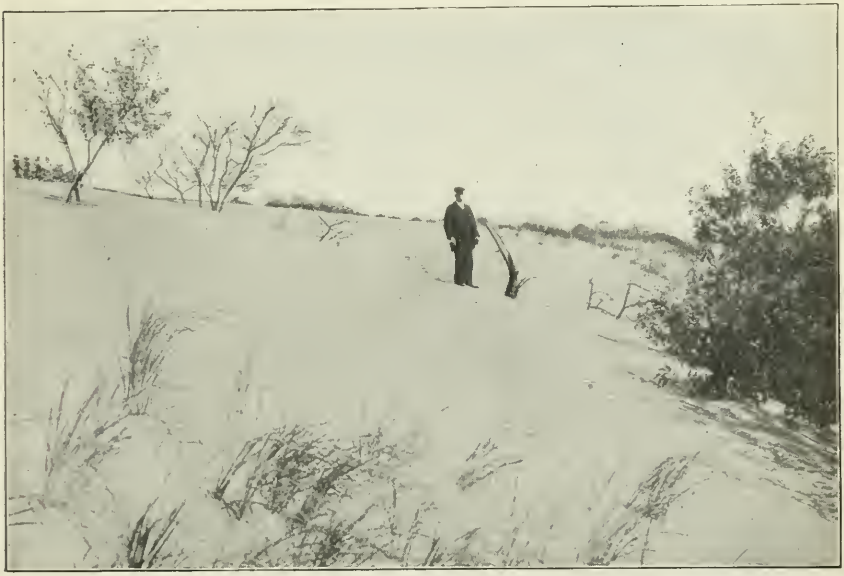


FIG. 2.—VIEW AT CAPE COD, MASS., SHOWING SAND DRIFTS BURYING FOREST TREES.

From a photograph by F. Lamson-Scribner.

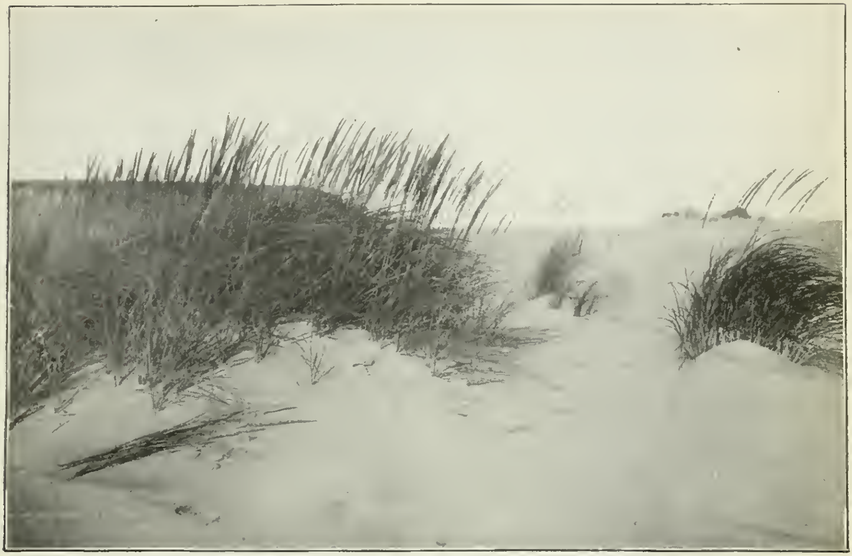


FIG. 1.—NATURAL GROWTH OF BEACH GRASS (AMMOPHILA ARENARIA) AT CAPE COD, MASS.

From a photograph by F. Lamson-Scribner.

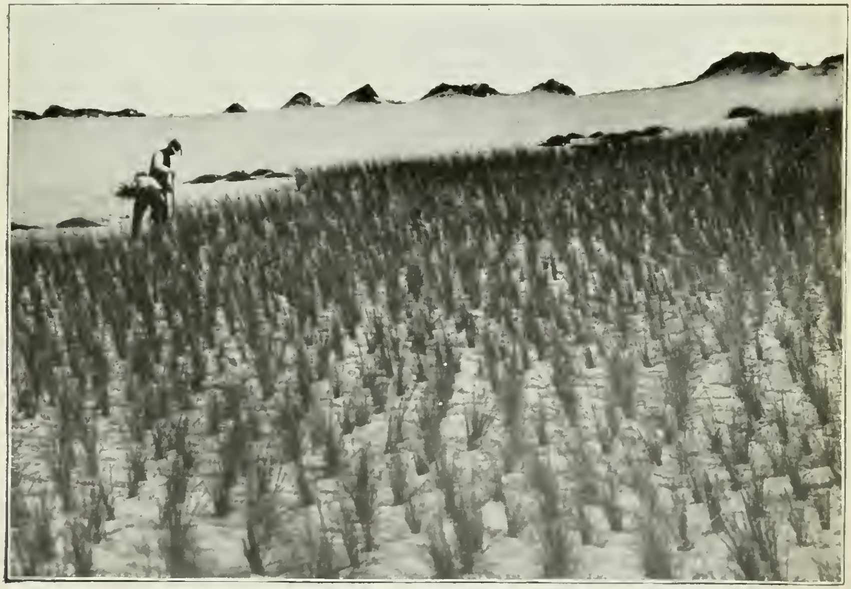


FIG. 2.—PLANTING BEACH GRASS (AMMOPHILA ARENARIA) AT CAPE COD, MASS.

From a photograph by F. Lamson-Scribner.

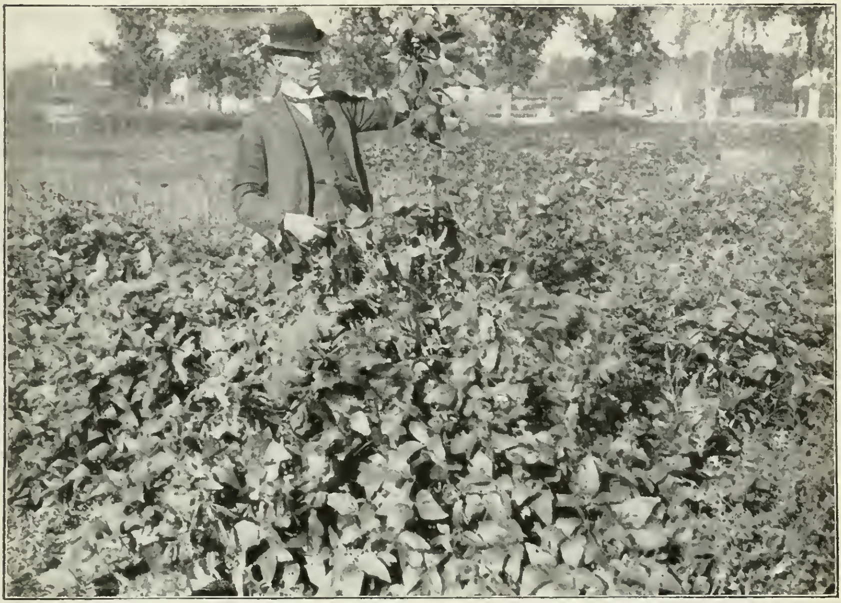


FIG. 1.—CHINESE SOY BEAN (GLYCINE HISPIDA VAR.). GROWN ON POTOMAC FLATS, WASHINGTON, D. C.

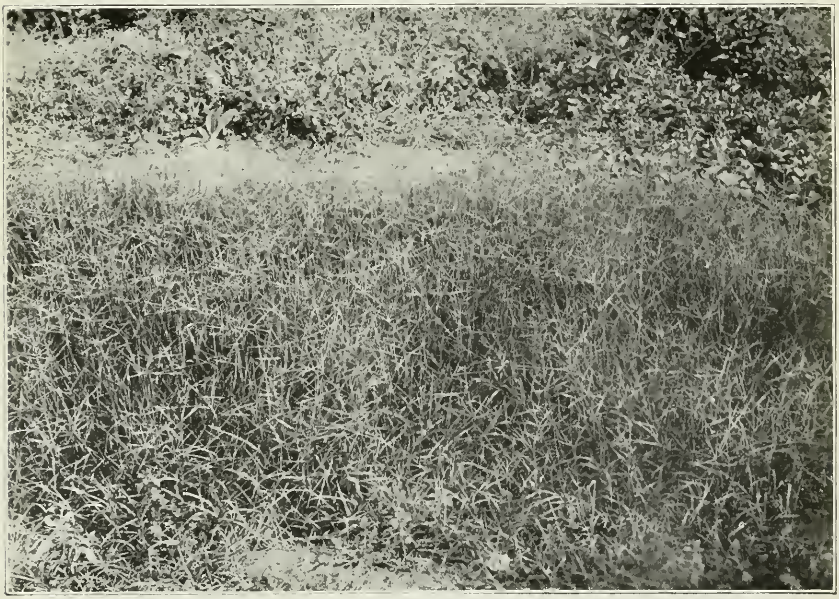


FIG. 2.—BERMUDA GRASS.

roots were obtained for transplanting in order that a careful study of the plants might be made under cultivation to demonstrate if possible the practicability of their general use.

REVIEW OF THE FIELD WORK BY REGIONS.

ATLANTIC COAST.

Besides forage problems the Division was charged with the investigation of grasses as soil and sand binders. The extensive areas of shifting sands along the Atlantic coast have for many years attracted attention and led to efforts to devise some means of holding them. Besides the interference with navigation frequenty caused by the shifting of these sands there is a continual destruction of the agricultural lands bordering the coast by the gradual encroachment of the drifting sand. Investigations along this line have been made on the coast near Provincetown, Mass. on Cape Cod, where there are extensive areas of shifting sands, and experiments in growing and transplanting sand-binding grasses have been carried on (Pl. I). The beach grass (*Ammophila arenaria*) which is native along the Atlantic coast has been very useful in preventing the drifting of the sand and has been transplanted over quite extensive areas on Cape Cod under the authority of the State of Massachusetts (Pl. II). Investigation of the native sand-binding grasses has also been made at various other points along the Atlantic coast, and it has been found that there are a number of very valuable native grasses which act as sand binders. Besides the beach grass, which is not indigenous south of Virginia, there is the sand rye-grass (*Elymus arenarius*), occurring from Massachusetts northward: the bitter panic (*Panicum amarum*), extending from Connecticut south along the Atlantic and Gulf coast, and sea oats (*Uniola paniculata*), another important sand binder occurring from Virginia southward and along the Gulf coast. Experiments have demonstrated that these grasses can be readily transplanted and very successfully used in preventing the drifting of the sands. Besides the transplanting of roots of sand-binding grasses large quantities of seed, especially of the beach grass, have been secured from Provincetown, Mass., for distribution and trial at various points, not only along the seacoast but also along the shores of the Great Lakes where similar trouble is caused by the shifting sand. The Chief of the Division has investigated the question of sand binders at several points on the Maine coast; at Cape Cod, Massachusetts, and also in the vicinity of Charleston, S. C., and Savannah, Ga., where, at the request of the War Department, experiments were undertaken in preventing the shifting of sand in the vicinity of the fortifications.

Mr. Allen Scribner did field work on Cape Cod, collecting a large quantity of beach-grass seed as well as a considerable number of roots for transplanting.

Mr. T. A. Williams, late assistant chief of the Division, did work in the vicinity of Norfolk, Va., securing seeds and roots of the bitter panic grass and a closely related species, which was considered new, and has been described in Circular No. 29 of this Division as *Panicum amaroides*, Scribn. & Merrill.

Mr. T. H. Kearney, formerly an assistant in the Division, also did field work at Norfolk, Va.; Wilmington, N. C., and Savannah and Augusta, Ga.

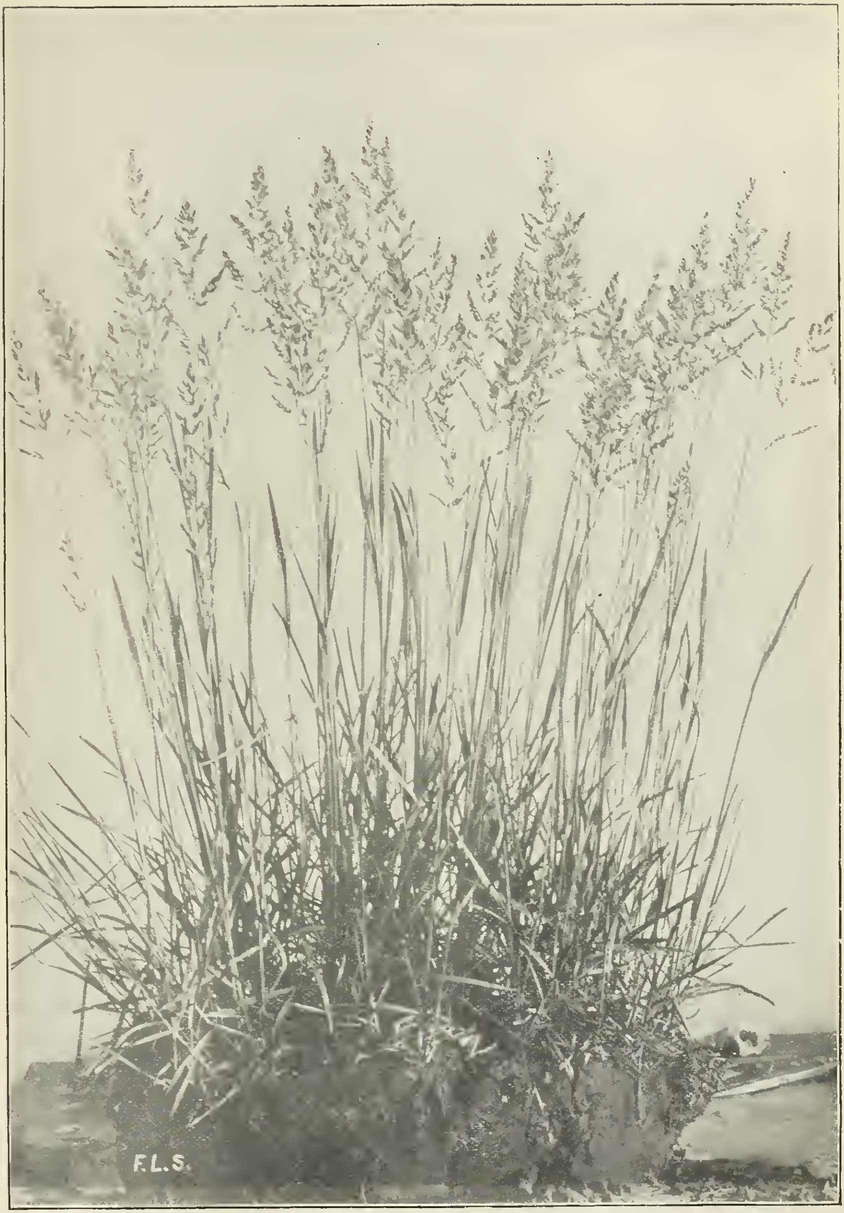
The question of the restoration of worn-out meadows and pasture lands is one of considerable importance in the Atlantic coast region, and particularly so in the New England States. Field studies of this question have been made by the Chief of the Division in Maine and Massachusetts, and experimental work looking toward the solution of this problem has been already arranged with the New Hampshire Experiment Station.

No separate publication giving the results of the field work done along the Atlantic coast has been issued. Much of the matter contained in Professor Scribner's Yearbook article for 1894 on "Grasses as sand and soil binders" was the result of this work, and also the article on "Sand-binding grasses" by the same author in the Yearbook for 1898. Bulletin No. 1 of the Division contains the results of Mr. Kearney's work in this region. An alphabetical and systematic list of the grasses and forage plants found is given with notes upon their habitat, habit of growth, distribution, abundance, and economic value.

GULF COAST.

CONDITIONS AND PROBLEMS.

The forage problems in the Gulf States are very numerous and varied. Their great importance was early recognized, and investigations commenced immediately after the organization of the Division. The long continued cultivation of single crops, especially cotton, had greatly impoverished the soil and led the more progressive planters to see the necessity of adopting a more diversified system of agriculture. Until quite recently a considerable portion of the hay consumed in the Gulf States was imported from other localities, and it was commonly believed that good pastures and meadows could not be made in that region. The great diversity of soils and climatic conditions, together with the presence of between 300 and 400 species of native grasses found growing in these States, naturally suggested the belief that the commonly accepted view regarding the forage possibilities of this region was erroneous. The great abundance of native grasses indicates that the South is naturally a grass producing country, and that considerable



TEXAS BLUE GRASS (POA ARACHNIFERA). A NATIVE SPECIES VALUABLE FOR THE GULF STATES.

Photographed from specimens grown at Washington, D. C., by F. Lamson-Scribner.

areas may be profitably devoted to meadow and pasture purposes. It was desirable at first to find what these native grasses were, the soil and climatic conditions under which they flourish, and the forage value of each, as well as the special purposes to which they were adapted. There was also the question of the introduction of various cultivated grasses and forage plants, and the testing of their adaptability and value.

The climate of this region is so favorable to the growth of grasses and forage plants that by proper succession pasture can be secured during the whole year, hence it was very desirable to ascertain what plants were best adapted to each season, and what the most profitable succession of seeding might be. Another question of great importance was the best method of improving and restoring the worn-out soils by the cultivation of the various leguminous forage plants, such as cowpeas, soy beans (Pl. III, fig. 1), and clovers, which, while producing large crops of hay or green forage, at the same time improve the chemical and mechanical condition of the soil and act as fertilizers.

WORK DONE.

An investigation of these various problems was begun by the Division immediately after its organization and has been continued every season since. The first work was done by Mr. Kearney, who visited various places in Alabama, Florida, and Georgia, besides the other points mentioned in referring to the field work done in the Atlantic coast region. A large collection of the grasses and forage plants of this region was made. Valuable information was secured by observation and careful field studies and also by interviews with various people familiar with the conditions and problems in question. The great value of the native hay and pasture grasses was definitely ascertained, as well as the possibilities in the way of introduction, cultivation, and more general use of the "tame" grasses and forage plants adapted to the various localities. The results of this field work were published in Bulletin No. 1 of this Division, entitled "Notes on the Grasses and Forage Plants of the Southeastern States." Notes on the most important grasses and forage plants for various purposes are given, also a complete list of all the grasses collected.

Prof. S. M. Tracy, formerly director of the Mississippi Agricultural Experiment Station, who from his long experience in the South and careful study of its forage problems was especially fitted for the work, was engaged to undertake an investigation of the forage conditions and questions of the Gulf States for this Division. He has done a large amount of field work in Georgia, Alabama, Mississippi, Louisiana, and eastern Texas, giving attention to all the various phases of the forage problems of the region. The results of this work were published as Bulletin No. 15 of this Division, entitled "A Report upon the Forage Plants and Forage Resources of the Gulf States." In this bulletin a rather thorough discussion is given of the various soil conditions, natural pastures, formation and care of pastures, temporary pastures, winter pastures, and also descriptions of the more important forage plants, with methods of cultivation and care of soils, and extended notes upon the more important hay and pasture plants of the region.

Professor Tracy, in speaking of the natural pastures, says:

> The natural forage plants vary as widely as the soils. Some adapt themselves to almost any situation and are quite general in their distributon, while others are extremely local. Some become more vigorous and abundant under frequent grazing, while others soon disappear with any change of surroundings.

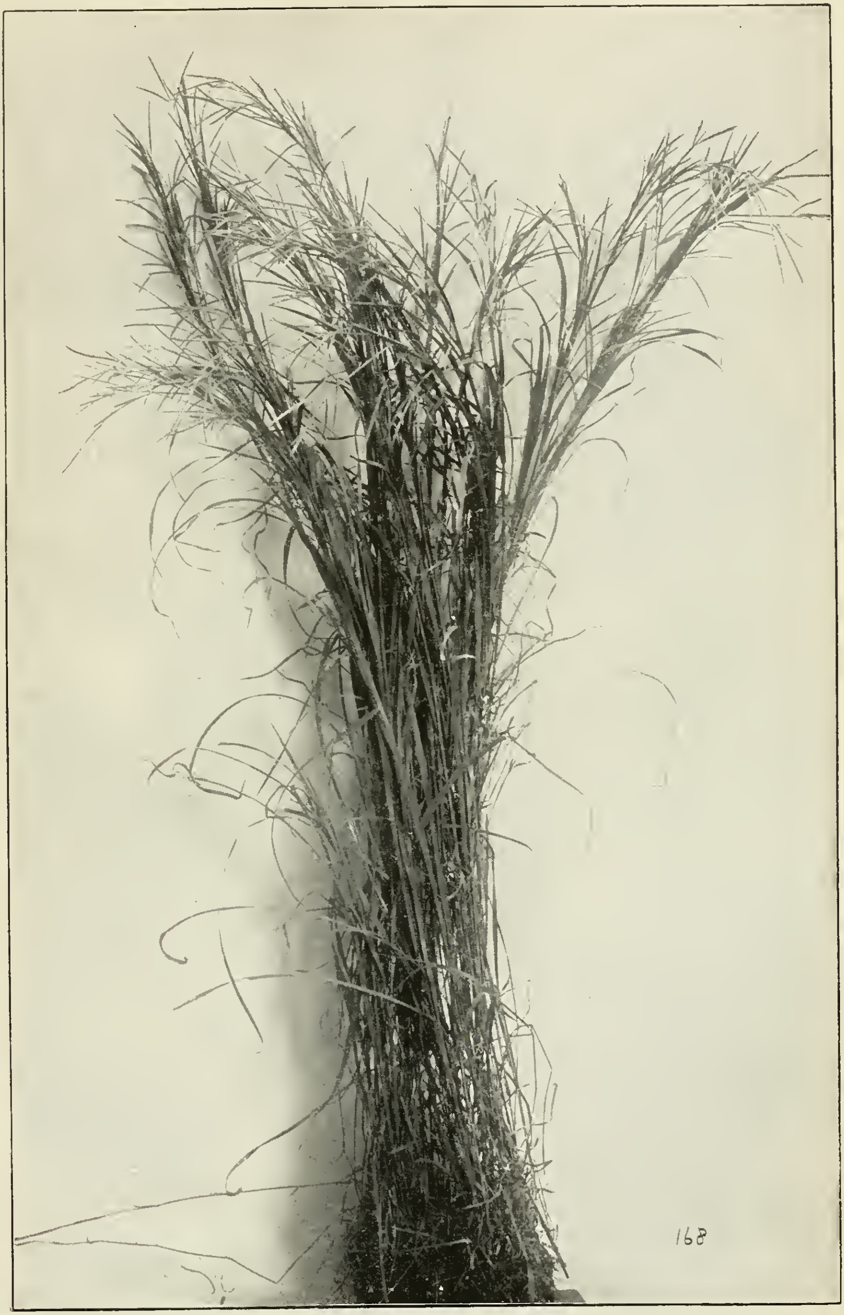
In regard to the formation of pastures, we may quote the following from the same report:

> With a climate favorable to almost continuous growth and with soil easily worked and promptly responding to good management it is not difficult to secure permanent pastures of the highest quality, and in order to obtain the best returns the same intelligent care must be used in their management as is given other portions of the farm. The best pastures are those which contain the greatest variety of plants yielding palatable food for stock. These plants should be such as make their greatest growth at different seasons, in order that there may be a continuous supply. A portion of them should be legumes, both for their superior fattening qualities and their effect upon the soil, and as large a proportion as possible should be perennials.

Carpet grass (*Paspalum compressum*) is excellent for pastures, especially on the thin sandy lands along the Gulf coast. It is a native and tends to spread and increase as the other and coarser grasses are destroyed by grazing. Its increase can be materially hastened, according to Professor Tracy, by mowing old pastures in July or August, when the grass is maturing seed, and scattering the hay thus made over the new field. For the more fertile lands Bermuda grass is most valuable (Pl. III, fig. 2). In speaking of the selection of varieties for pasture the following advice is given:

> For the whole of the Gulf States, excepting the sandy soils near the coast, Bermuda grass and Japan clover should be the foundation of every permanent pasture. On alluvial lands add redtop and alsike clover for the damper lands, with orchard grass, sweet clover, and bur clover for the drier lands. On the uplands, yellow loam, and clay sections, orchard grass and bur clover do well on the dry soils, while for wet places redtop, large water grass, and alsike clover should be added. For the black prairie regions, Texas blue grass (Pl. IV) and sweet clover are the best additions. On the light soils of the coast region, carpet grass, large water grass, giant beggar weed, and mutton cane largely replace the redtop and clover of the more Northern sections.

The question of the best crops for winter pastures is one of considerable importance in this region. It has been found that oats, rye and barley, and hairy vetch prove the most satisfactory. A mixture of turf oats and hairy vetch give especially good results. Rescue grass is also valuable for the same purpose. As a hay crop Bermuda



BIG BLUE-STEM (ANDROPOGON FURCATUS). A VALUABLE HAY AND PASTURE GRASS OF THE GREAT PLAINS.

From a photograph.

grass is most largely used. The sod, however, frequently becomes so matted that it should be disk harrowed in order to give the grass a fresh start. Of the annual hay plants, cowpeas are regarded as the most important and best. The large number of varieties, with the varying lengths of time required for growth, makes it possible to adapt them to various uses, so that they can be grown on land from which grain or any early crop has been harvested. The benefit which the soil derives from them is also of much importance. Crab grass (*Panicum sanguinale*) is also used very largely for hay. It is a volunteer crop, taking possession of fields upon which grain or similar crops have been grown, and produces a large amount of excellent hay, especially on the richer soils. The hay is of good quality, but needs considerable care in curing. German millet, Johnson grass, and red clover are also extensively cultivated for hay. Professor Tracy's report has been in great demand and has done much to increase the knowledge and interest of the farmers of the South in forage questions, and has also tended greatly toward the improvement of conditions.

Mr. C. R. Ball did field work two seasons in Louisiana, making especially large and important collections in the northern part of the State and investigating a region whose forage problems and conditions had not been before carefully studied. His collections and notes have added much to our knowledge of this region. The report of these investigations has not yet been published, but is in course of preparation and will soon be submitted in connection with a complete account of all the unpublished results of field work in the Gulf States.

Mr. Robert Combs, accompanied by Mr. Allen Scribner, spent several months during the summer of 1898 in northern, central, and western Florida, making a careful study of the forage resources of that State. Large portions of Florida have been found to be particularly well adapted to stock raising. Over large areas only a very small proportion of the land is under cultivation, so that stock have an abundant range in the woodlands, where there is an excellent supply of grass and other forage. The growing season being practically continuous, there is no lack of feed at any time during the year. For this reason very little attention has been given to cultivated forage plants. As the area of cultivated land increases, however, it will be found necessary to pay more attention to the establishment of permanent pastures and meadows, and also to the proper preservation and care of the more important native grasses and forage plants. It is very important that these questions should be carefully looked into and the proper steps taken before the ranges reach the serious condition of those in some other parts of the country, and it is hoped that the investigations which have been undertaken will result in the conservation and proper care of the natural forage of this State. A very large collection of the grasses and forage plants was secured, which has added very materially to our knowledge of the native species, their distribution, abundance, and value. The general results of these field studies have not yet been published, but the careful and valuable notes secured by Messrs. Combs and Scribner will be incorporated in the report on the Gulf States referred to above. Besides the above-mentioned field work in this region, Prof. F. Lamson-Scribner, Chief of the Division, has spent short periods at several points in Florida with especial reference to the question of sand-binding grasses of the region, and has also compiled, from the reports of the various field workers in the South, Farmer's Bulletin No. 102, "Southern Forage Plants," which treats in a simple and condensed manner the various forage problems and plants of the South, giving directions for formation and care of pastures, describing soiling and fodder crops, and giving a thorough account of the more important hay and pasture plants, with descriptions, illustrations, methods of cultivation, relative value, etc., of each.

THE GREAT PLAINS.

CONDITIONS AND PROBLEMS.

The Great Plains region, as limited for the purposes of the present discussion, extends from North Dakota south to Indian Territory and west to the foothills of eastern Colorado, Wyoming, and Montana. Though the area under consideration includes many million acres, yet the grasses and forage plants and climatic conditions are very similar throughout. The annual precipitation decreases over the whole region as one goes from the eastern border to the western. In the eastern portions of Kansas, Nebraska, and the Dakotas the annual precipitation averages from 25 to 30 inches. In the western portion of the Great Plains the rainfall is much less, the annual precipitation averaging from 10 to 20 inches. In the first half of the last century nearly all of this territory was included on the maps of the period under the title of the "Great American Desert." As the tide of immigration proceeded westward and the actual conditions became more definitely known, the imaginary borders of this desert were gradually pushed westward. The very fertile soils of eastern Kansas, Nebraska, and the Dakotas were found to produce abundant crops of wheat, corn, and other cereals, and rapid settlement and development of the country immediately followed. Attracted by the glowing accounts given by the early settlers, farmers from the East and immigrants from Europe continued to take up land and begin the cultivation of the soil. It was soon found by experience that while excellent crops were usually certain in the eastern borders of this region, the amount of moisture available during the season decreases so rapidly as you proceed westward that after passing the ninety-eighth meridian the production of corn and wheat is a matter

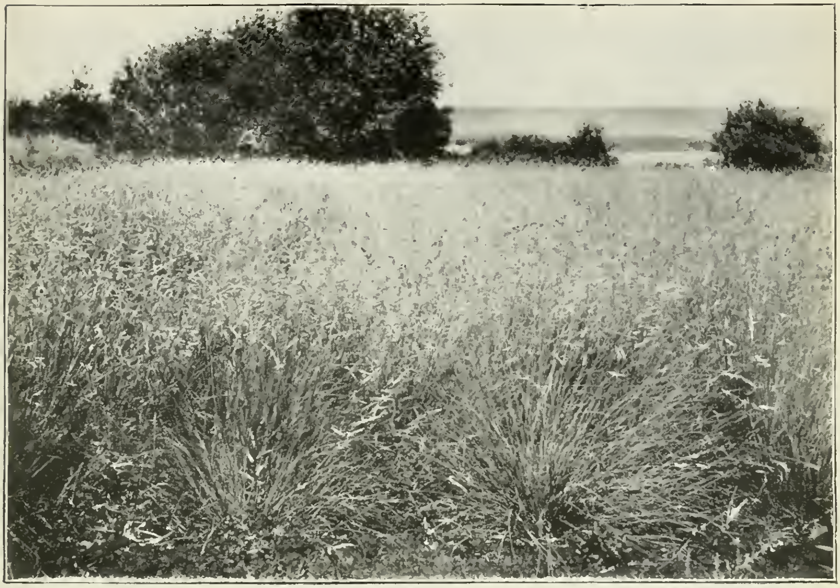


FIG. 1.—BLUE GRAMA (BOUTELOUA OLIGOSTACHYA), AS GROWN IN GRASS STATION AT WALLA WALLA, WASH.

From a photograph by A. B. Leckenby.

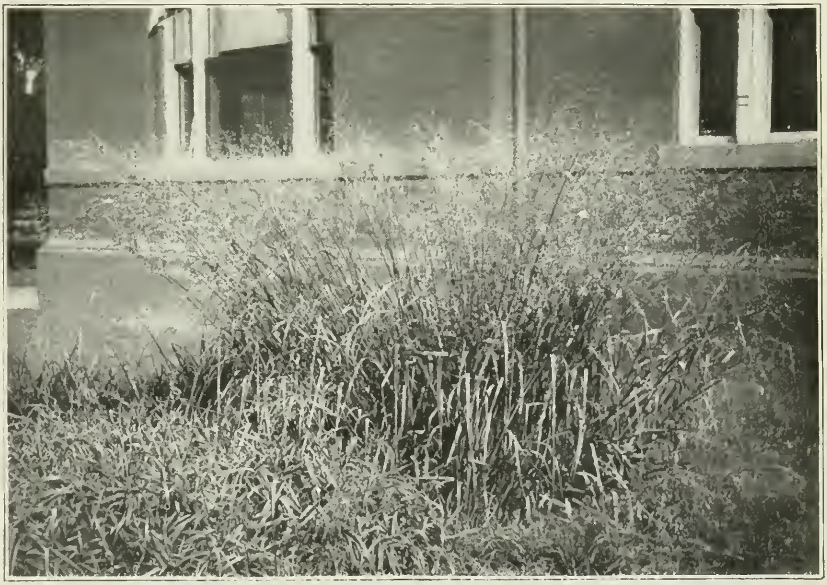


FIG. 2.—SWITCH GRASS (PANICUM VIRGATUM), AS GROWN IN THE GRASS GARDEN AT WASHINGTON, D. C.

From a photograph by C. L. Shear.

of considerable uncertainty. Nevertheless, influenced very often by unscrupulous persons who were willing to profit by the ignorance on the part of the home seeker of the actual conditions, people continued to take up these lands farther and farther west, in central and western Kansas and Nebraska, and break the virgin prairie sod with its luxuriant growth of native grasses, in hope of growing profitable crops of cereals. In this, however, they were destined to disappointment. Experience has shown that beyond the ninety-eighth meridian profitable crops of cereals are not produced oftener than one to three times in five years, so that farming without some means of irrigation can not be made a financial success.

Those who possessed sufficient acumen to appreciate these facts turned their attention at once to stock raising; but under the impression, apparently, that the forage resources of the country were inexhaustible, the pastures were overstocked and soon their carrying capacity was greatly lessened. When the more progressive stockmen began to realize that the native pastures were rapidly deteriorating and were threatened with destruction if the same treatment was longer continued, they began to make inquiries regarding the matter, wishing to find some remedy. Many of the people began to gradually realize that they had made a serious mistake in breaking these fine pasture and meadow lands in a hopeless endeavor to produce paying crops of wheat and corn. Thus they began to inquire as to what could be done to put down these cultivated lands to permanent meadows and pastures again. As the people turned their attention to stock raising and dairying, the question of drought-resistant soiling crops and other forage plants which might prove successful also naturally arose. It was in response to pressing demands for information along these various lines that the Division of Agrostology began immediately after its organization to undertake a thorough investigation of the different problems referred to.

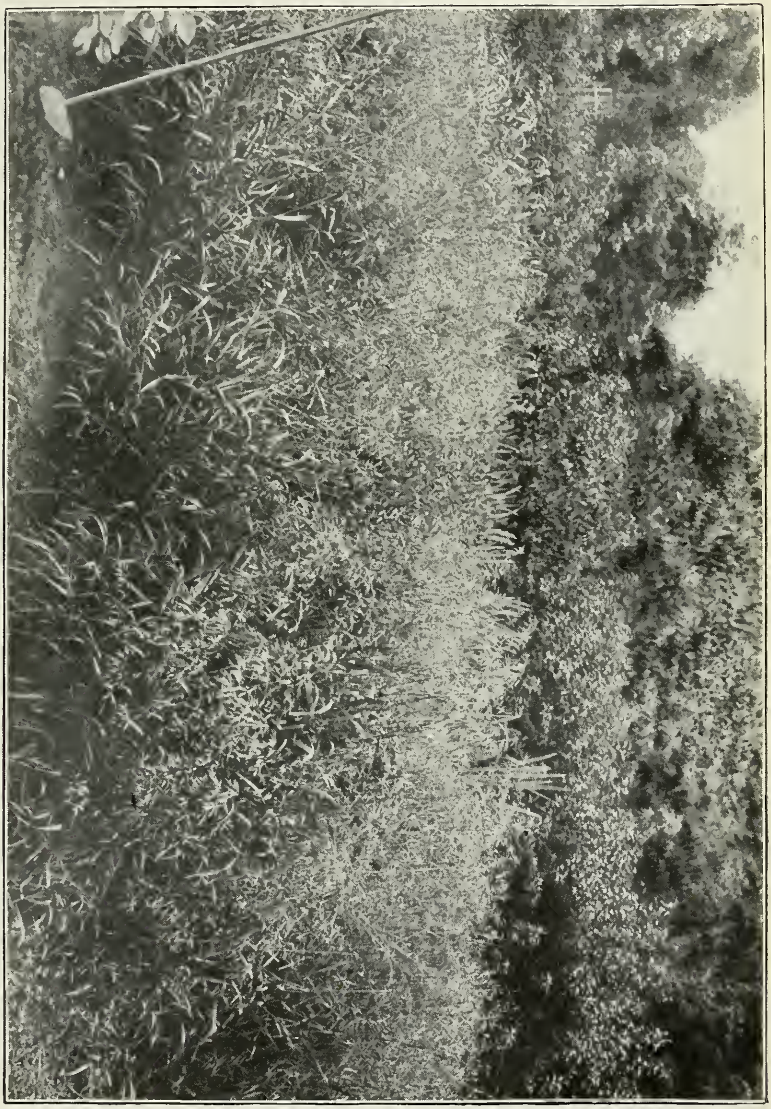
WORK DONE.

Field work was commenced in this region by Mr. P. A. Rydberg and the writer. Studies and collections of the grasses and forage plants of the Platte River Valley were made at Valley, Central City, Kearney, and North Platte, Nebr. Collections of roots, seeds, and specimens of the more important native species were collected and careful notes made regarding the forage value, abundance, distribution, and importance of each. With the seeds and roots secured, plots in the grass garden on the Department grounds at Washington were made and an opportunity afforded for studying the behavior of these plants under cultivation. The results of this field work were published in Bulletin No. 5 of this Division, entitled "A Report on the Grasses and Forage Plants of the Rocky Mountain Region." The major portion of the report was devoted to investigations made in the Rocky Mountains, the work done in Nebraska being incidental.

Other field work in Nebraska has been done by Mr. C. J. Elmore, Dr. L. H. Pammel, Mr. T. A. Williams, late assistant agrostologist, Mr. J. G. Smith, who formerly occupied the same position in the Division, and also by the writer. Mr. Elmore did field work during a portion of the summer of 1896 in the southwestern part of the State, especially in Nemaha and Otoe counties. He devoted especial attention to the collection of sheaves of the native grasses and forage plants to be used for exhibition purposes by the Division and for distribution and exchange to various institutions, particularly the experiment stations. In this way a considerable number of specimens were added to the herbarium, and duplicates were also secured for distribution and exchange. During the same season Dr. L. H. Pammel, under commission from the Secretary of Agriculture, made a study of the forage conditions of western Iowa, Nebraska, and Colorado. The points at which work was done were as follows: Ames, Iowa; Omaha, Lincoln, Crete, Hastings, and McCook, in Nebraska, and also in northern and central Colorado in the vicinity of Fort Morgan, Greeley, Fort Collins, Golden, Denver, and Colorado Springs. A discussion of the Colorado work will be taken up in connection with the account of the work in the Rocky Mountain region. The results of Dr. Pammel's work were published in Bulletin No. 9, entitled, "Notes on the Grasses and Forage Plants of Iowa, Nebraska, and Colorado."

A quotation from Dr. Pammel's report will give an idea of the situation in Iowa:

> The forage question in central Iowa is very different now from what it was fifteen years ago. At that time considerable areas of unbroken sod still remained. Now the wild prairies have almost ceased to be a factor in the production of hay. The extensive prairies have given way to cultivated fields and pastures. Small unbroken areas occur here and there, but these are chiefly confined to the small drainage basins between hills, and exist largely because in times of considerable precipitation these depressions are too moist for proper cultivation. The Boyer and Maple valleys are noted for the large crops of wild hay annually produced. The same may be said of the rich alluvial flood plain of the Missouri. This plain varies from a few to 15 miles in width, the average being from 8 to 12. The hay crop constitutes one of the chief sources of revenue for the farmers of this region, and could be made much more important if they would follow a more rational system of cropping.
>
> The chief hay plants in central Iowa are timothy, redtop, blue grass, and red clover. The principal plants used in pastures are blue grass, white clover, redtop, and timothy. In the Boyer and Maple valleys and on the Missouri bottoms the wild grasses predominate. To a limited extent alfalfa meadows have been started in Carroll, Ida, and Woodbury counties. The loess hills skirting the Missouri bottoms are mostly cultivated, though unbroken wild meadows and pastures still remain. In the eastern portion of this district considerable corn fodder is used as forage, the amount used depending largely upon the condition of the pastures and meadows.
>
> Many other grasses have been tried with varying success. Orchard grass, naturalized in many places, is one of the most successful. Tall oat grass gives some promise.



AWNLESS BROME GRASS (BROMUS INERMIS), SHOWING PLAT OF THE GRASS GROWN IN THE UNITED STATES GRASS GARDEN, WASHINGTON, D. C.

This grass has proved a success throughout the northern portion of the Great Plains region. From a photograph by F. Lamson-Scribner.

Perennial rye grass is nearly worthless for this section of the State. Italian rye grass is unable to resist the cold of our winters and is a complete failure. Meadow foxtail (*Alopecurus pratensis*) does fairly well as an early grass when sown the season before, but is hardly adapted to this section. The most promising of the recently introduced grasses is smooth or hungarian brome. The short-awned brome has also been tried and is very promising. Rye and barley are often used as forage plants. German millet and hungarian grass find extended use some seasons. Broom-corn millet is frequently sown in northern and northwestern Iowa.

But one legume is generally grown and that is red clover. Mammoth or medium clover is often sown, but is much less common than the preceding. Alsike clover is becoming more common. Two sweet clovers are not infrequent; the white sweet clover is more abundant than the yellow. Crimson clover has been tried repeatedly, but is not adapted to Iowa conditions. It suffers much from drought in late summer, and from insect and fungous enemies.

Many native species of grasses occur, and they vary in quantity and quality in different sections of the State. The dominant grasses of central Iowa are little blue stem and big blue stem. Both of these species are frequently called blue joints. Several species of *Elymus* are abundant, as wild rye, on the prairies and meadows; Lyme grass on the flood plains of streams, and Dennett grass along the borders of woods. Other common grasses are: Indian beard grass, or bushy blue stem, in prairies and open woods; tall grama grass of the dry prairies and gravelly knolls; nodding fescue in woods; slender fescue in dry sterile soils; Short's fescue in low prairies, a most valuable species; switch grass in rather moist meadows; satin grass (*Muhlenbergia racemosa*, *M. diffusa*, *M. willdenowii*, and *M. mexicana*) in most soil of open woodlands and meadows; swamp chess in open woodlands; fowl meadow grass in low grounds along streams; wire grass and squirrel-tail grass (an introduced species) in meadows and waste places; blue joint, reed canary grass, common reed grass, and floating manna grass in marshy places and shallow water; large rush grass and bunch grass in dry prairies. In northwestern and western Iowa the above as well as some additional species occur. Among the latter are western wheat grass, bearded wheat grass, blue grama, slough grass, and big sand grass.

The most widely distributed of all the native leguminous plants is Canadian rattleweed (*Astragalus canadensis*), a thrifty, hardy, and vigorous species found in woods, low meadows, and prairies. It is eaten by stock, but becomes rather woody when old. Buffalo pea, or ground plum, is common on dry, sterile hills throughout the region and affords valuable forage. American vetch is one of the most valuable of the native legumes. It grows in the moist soil of low prairies and open woodlands. This vetch is well adapted to the conditions of western and northwestern Iowa, and does well under cultivation. The prairie clovers (*Petalostemon violaceus* Michx., and *P. candidus* Michx.) are common on the prairies everywhere, as also on the loess soils of western Iowa. These plants are seldom eaten by stock unless forage is scant. *Dalea alopecuroides* Willd. is common throughout the loess region and has been introduced farther eastward. Wild vetch, well known as a valuable forage plant of the Northwest, is indigenous to the loess, though not abundant except locally. It has been introduced into Boone County. Running buffalo clover (*Trifolium stoloniferum* Muhl.), a native, is considered a valuable forage plant by the farmers of western Iowa, and is worthy of a trial under cultivation. Mention should also be made of a loco plant (*Oxytropis lambertii* Pursh.) native to this region. Though often consumed by stock, no complaints have been made that it produces loco poisoning. Rattlebox (*Crotalaria sagittalis* L.) occurs in the more sandy bottoms of the Missouri River. Complaints have frequently been made of the trouble it causes when fed to horses. The disease it produces has been called "crotalism."

There are some serious obstacles in the way of maintaining the native meadows and pastures of Iowa. These may be classed under two heads—the overstocking of pastures and the growth of weeds. Many farmers attempt to raise more stock than their pastures will safely accommodate. The grasses can not endure the close grazing and excessive trampling to which they are subjected, and consequently they die out. Snow in this section of the State is usually blown from the open fields soon after falling, and hence can not be depended upon to protect the grass roots in pastures that have been too closely grazed. As a result of this, weedy annuals, like southern poverty grass, foxtail and squirrel-tail, spring up to take the place of the better perennial species, or the native ragweeds and verbenas spread and occupy the soil. All of these have become so plentiful that farmers remark on their more frequent occurrence now than in former years. Several rank-growing weeds are abundant in meadows and pastures of western Iowa. Sunflower and marsh elder find in the rich alluvial soil of the river bottoms a most congenial place for their development. They are especially troublesome on land that is often flooded during spring freshets. It may be that farmers of this region who rely chiefly on the hay crop will be obliged to introduce better turf-forming grasses, such as can resist the inroads of these weeds. From what I have seen of blue grass in this region it may prove a good grass for this purpose, and hungarian brome (*Bromus inermis*) may prove of even greater value. Snow-on-the-mountain (*Euphorbia marginata*), a well-known ornamental plant, is a serious pest in western and northwestern Iowa. Golden rods are often troublesome in pastures, especially *Solidago canadensis* and *S. rigida*. Stock will not eat them unless forced to do so, and when once well established in the pasture they are very difficult to eradicate.

In regard to Nebraska Dr. Pammel writes as follows:

Grazing is now and ever will be an important industry in the western half of the State. Although the grasses may not grow so luxuriantly season after season in Nebraska as in Iowa, the climate is more favorable for winter grazing than in the latter State, and there is a large number of valuable species of native forage plants.

Under the head of native grasses the great value of the more important species is referred to, the necessity of the careful conservation of the natural hay and grazing lands is urged, and the great injury resulting from overstocking is pointed out.

Mr. Williams's work in this region was carried on at different times since 1896 in eastern Nebraska, eastern, central, and western South Dakota, and also in southeastern North Dakota. Mr. Williams was particularly well fitted for attacking the forage problems here on account of his long residence in the region and the careful and special study which he had given the subject, especially while acting as botanist of the South Dakota Agricultural Experiment Station. The results of his field work in this region, as well as those of Mr. E. N. Wilcox, Dr. David Griffiths, and Mr. M. A. Brannon, were published in Bulletin No. 6, "Grasses and Forage Plants of the Dakotas." A general review was made of the farming and stock-raising regions of North and South Dakota, indicating the characteristics of the various natural areas and pointing out the special advantages of each for various agricultural and forage purposes. A description of the native grasses is given and the value of each for different purposes is pointed out. Attention is particularly called to the great value of the natural

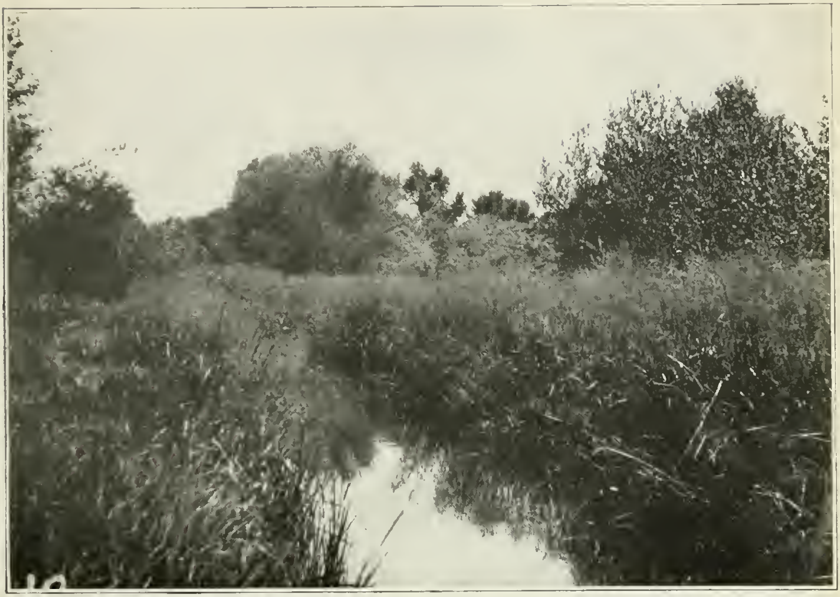


FIG. 1.—AMERICAN MANNA GRASS (PANICULARIA AMERICANA). A WET MEADOW GRASS.

From a photograph by C. L. Shear, taken near Antonito, Colo.

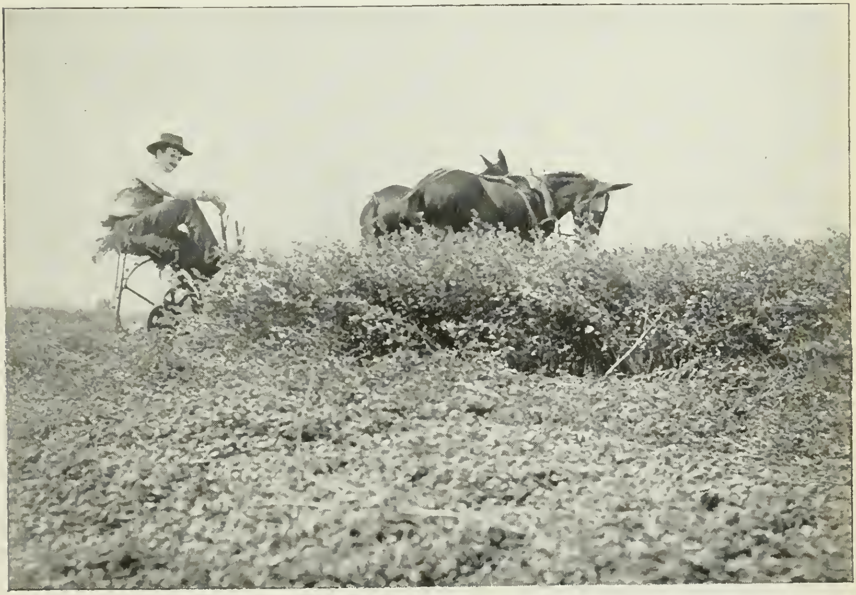


FIG. 2.—ALFALFA, BELLEFOURCHE, S. DAK., 1897.

forage and the importance of making every possible effort to preserve it. In speaking of overpasturing, he says:

> Overpasturing in times of drought is killing out many of the permanent grasses here as well as elsewhere, and unless this practice is abandoned permanent injury will result to this, one of the most important of the natural resources of the Northwest.

The irrigation problem is also discussed, and some of the possibilities in the way of developing the water supply afforded by the artesian basin are spoken of. The great increase in the production of the native grasses by a slightly increased supply of moisture is referred to as follows:

> Experience has shown that many of the most valuable native grasses are very much benefited by a judicious application of even a small amount of water. As a rule there is sufficient rainfall to give the grasses a good start in the spring, and if enough water could be had to keep up a strong growth when the dry, hot weather comes on an abundant forage crop would be assured.

Besides the general discussion of the results of field work covered by the report there is given a complete list of the grasses and forage plants collected by the different field agents in this region, and also a list of the grasses and other forage plants of the Dakotas which are or may be of importance as forage, giving notes on each species, pointing out their particular characteristics and adaptation to special purposes, and also making suggestions regarding their treatment, method of sowing, and possible means of improvement. Besides the bulletin referred to, Mr. Williams published, in Circular No. 4 of the Division, further results of the field work in this region under the title of "The Renewing of Worn-out Native Prairie Pastures," in which attention was called to the rapidly deteriorating condition of the native pasture lands, at the same time pointing out the causes and results, and recommending methods for improving and renewing these native grazing lands.

The general effects of cultivation on native grasses and the great value of the same is pointed out, especially the beneficial results which are derived from disk harrowing and thus loosening the soil which has been greatly hardened by tramping of stock, so that the roots of the grasses may have an opportunity to develop. The question of manuring native pastures is also discussed, and the conclusion is as follows:

> Pastures which have been grazed closely for some time will be benefited by the application of a thin top dressing of well-rotted stable manure, followed by a thorough harrowing. It is doubtful if much is gained by putting coarse unrotted manure on the pasture. It can be used to better advantage on cultivated lands. Ashes generally have a beneficial effect on soils not too plentifully supplied with alkali. The collecting and sowing of seeds of the best native grasses, such as western wheat grass (*Agropyron occidentale*), slender wheat grass (*Agropyron tenerum*), wild rye grass

(*Elymus canadensis*), prairie June grass (*Kœleria cristata*), and the beard grasses (*Andropogon* spp.) is recommended, and an instance is cited of an excellent pasture of western wheat grass having been secured in this manner.

Small portions of Bulletin No. 12, by the same author, relate to this region, extracts from a report on work by Dr. Griffiths in western South Dakota, in 1897, being given.

Mr. Jared G. Smith, during his connection with the Division, did field work in Kansas, Nebraska, and South Dakota, besides having made a special study of the forage problems of the region during a long residence in Nebraska, a portion of which time he was connected with the agricultural experiment station of that State. The results of his work were embodied in an article published in the Year Book of the Department of Agriculture for 1895, entitled "Forage conditions of the prairie region." After a general consideration of the subject, in which the vast area of the region is referred to and the prevailing physical conditions and agricultural products mentioned, a discussion of the most profitable crops to be grown is considered.

The necessity for a more diversified system of agriculture is pointed out, and the greater profit to be derived by growing less corn and wheat and more grass and cattle is clearly shown. In this connection he says:

> It has been demonstrated, both by experiment and practice, that the farmer who sells beef, pork, and mutton, that he has produced from corn and grass raised and fed on the farm, makes more money per acre of his land and per dollar of his capital than the one who grows only wheat or corn or cotton.

The following quotation, which gives a comparison between the present and past condition of the prairies, is of interest:

> The prairies in their wild state were covered with the richest possible grass flora. There was no similar region that had so many useful species and so few poisonous or injurious ones. Almost any square mile of the whole extent of territory could furnish in one season 50 kinds of grasses and native forage plants, grasses that would make from 1½ to 2 tons of hay per acre as rich as that from an Old World meadow. It was a magnificent legacy to the rancher and the farmer. To the one it promised food for a million cattle; to the other it proved the golden possibilities of a soil that would bring forth bountiful harvests. But within the last thirty years all this has changed. We can no longer point to our broad prairies and say that the natural forage conditions here are the best in the world. Hardly an acre remains anywhere east of the ninety-seventh meridian that will still yield its ton and a half of prairie hay. There is hardly a square mile of prairie sod that will produce 30 kinds of native wild grasses and clovers per annum.

The superior qualities of the more important wild species is pointed out, especially their ability to endure drought, freezing, and flood. The futility of attempting to replace the native species by introduced ones is also clearly demonstrated. The beard grasses (*Andropogon furcatus* (Pl. V) and *A. nutans*) are described, their great value for hay and their nutritive qualities given. Other important species discussed are switch grass (*Panicum virgatum*), western wheat grass (*Agropyron*

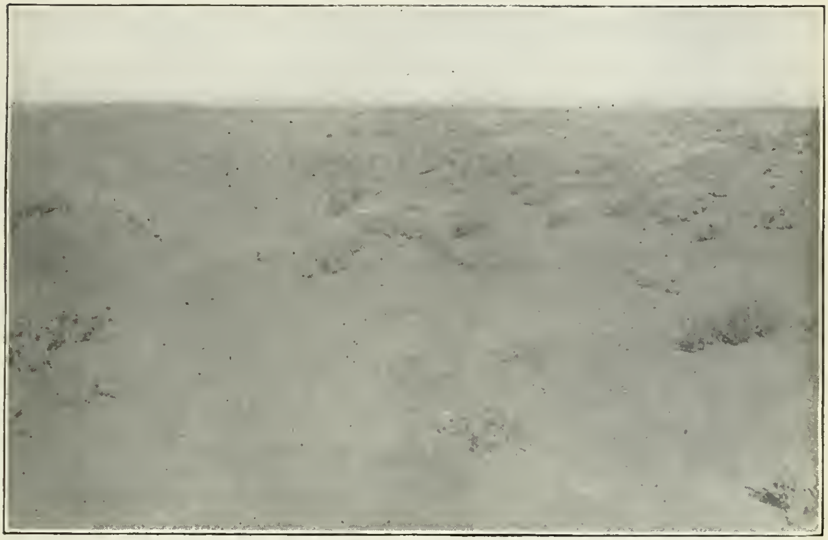


FIG. 1.—THE REAL RED DESERT, WYOMING.

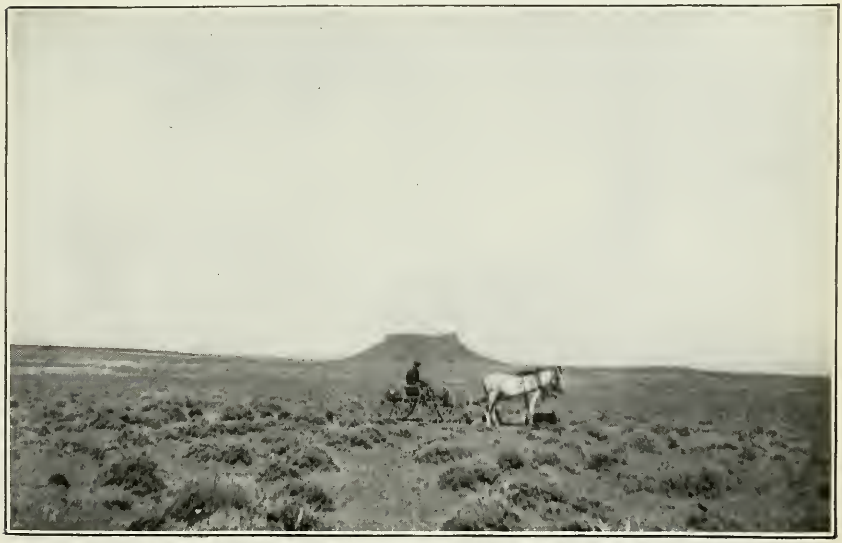


FIG. 2.—THE GREATER RED DESERT, WYOMING.

occidentale), the grama grasses (*Bouteloua curtipendula* and *B. oligostachya*), also buffalo grass (*Bulbilis dactyloides*), and prairie June grass (*Kœleria cristata*). Switch grass produces a very luxuriant growth, especially in the bottom lands and "draws" (Pl. VI, fig. 2). As it is inclined to get hard and woody when old, it should be cut before it has reached maturity. It is of most value for hay, being rather coarse for pasture. Its seeds are large and abundant and easily harvested. As it has been found to grow well under cultivation, it may be recommended especially for use in mixtures with other grasses. Western wheat grass is one of the best and most widely distributed of the native species in this region, especially for hay. It is everywhere highly esteemed and yields a good crop. The grama grasses are very abundant and important constituents of the upland prairies and meadows. The blue grama (*B. oligostachya*) is the most important one for pasture (Pl. VI, fig. 1). It forms a dense turf to the exclusion of other species, and it will endure a great amount of trampling, close-grazing, and drought. This species, together with the buffalo grass (*Bulbilis dactyloides*), forms the greater percentage of the forage over a large part of this region. It is scarcely necessary to point out the great importance and nutritive value of buffalo grass. Its qualities are well known and thoroughly established. It forms an excellent dense turf of very fine leaves, and spreads by means of runners. It will survive great hardships, and is about the last species to succumb under excessive grazing. Unfortunately this grass can not be readily propagated from seed on account of its scarcity and the difficulty of collecting it. It can, however, be easily grown from roots and cuttings. The turf may be broken into fragments and planted in shallow furrows, in the same manner that Bermuda grass is planted in the South. It has also been found to adapt itself readily to conditions in moister climates and poorer soils. It has been grown very successfully for the past five years in the grass garden of the Department at Washington, D. C., where it forms an excellent turf, and endures the climatic conditions as well as in its native prairie home.

The prairie June grass (*Kœleria cristata*) is widely distributed through the whole prairie region, and is particularly valuable as a pasture grass on account of its early appearance in the spring. It is, however, a bunch grass in habit and does not form a continuous turf. It is much liked by stock and stands pasturing well. The seed is produced in good quantity and the grass is one quite well adapted to cultivation.

Mr. Smith gives the following advice regarding treatment of the native hay grasses:

> With such yearly yields and at such prices it will pay to improve the prairie meadows so that the product shall not decrease in amount or deteriorate in quality. The wild hay grasses should be permitted to reseed themselves, if not one year in three, at least one in four or five. Cutting the grass early in the season would help

to keep down the weeds. It is a matter of observation that the species of weeds which increase most rapidly in the hay fields are those that blossom and ripen their seeds before the hay is ready to cut. Their increase can be checked only by cutting them while they are in flower and thus preventing the seed from ripening. The intermingled mass of weeds and grass along the "sloughs" and "draws" or on the ground where old stacks have stood should be mowed and burned, or at least raked off the field. Otherwise these weed patches will grow in size from year to year and reduce the yield of hay.

Tame grasses, clovers, and soiling crops for the prairie region are also discussed in this paper. Some of the tame grasses and clovers have met with success in the eastern portion of this region where the rainfall affords a sufficient supply of moisture. Orchard grass and red clover mixed have proven successful in eastern Kansas and Nebraska. Tall meadow fescue has also met with fair success, although it is not so enduring as orchard grass. Alfalfa (Pl. VIII, fig. 2) is quite generally and successfully grown, but most of the introduced grasses and forage plants are not adapted to the conditions of drought prevailing over the greater portion of this region.

On account of the growing interest in dairying which is manifested at present in the prairie region, considerable attention has been given to soiling crops, the question of summer forage being an important one, as there is usually a period during the summer when pasture is scarce. Among the most promising plants for this purpose cowpeas and soy beans may be mentioned. Certain varieties of these plants have been grown with much success during the past few years in various places, especially in Kansas and Nebraska. Very little has been done with them in the Dakotas, as the season is usually too short for maturing most of the varieties. Corn, millet, hairy vetch, and field peas also make excellent green feed for milch cows and are to be recommended where they can be grown successfully. For hay and pasture awnless brome grass (*Bromus inermis*) has proven more successful than any other introduced grass tried (Pl. VII). Being a native of arid regions, it naturally does well in this region.

Under the heading "Improvement of the ranges" the question of overstocking and its results is discussed, and the necessity for discontinuing the practice is pointed out. The desirability of constructing artificial ponds or tanks for the conservation of the rainfall is shown to be of great importance, as it would obviate the necessity of cattle having to travel long distances for water, and thus trampling and packing the soil. As one means of improving the range lands, we may quote in conclusion from Mr. Smith's paper the following:

> Clearly, then, if the grazing quality of the ranges is to be improved, they must be so treated that the nutritious native species of grasses and forage plants can spread by means of the ripened seed. This can be accomplished by dividing the range up into separate pastures and grazing the different fields in rotation. There is a constant succession of species that ripen their seed from June to October, commencing with *Kœleria*, *Eatonia*, *Stipa*, and *Bulbilis* in June and July, and ending with *Andro-*

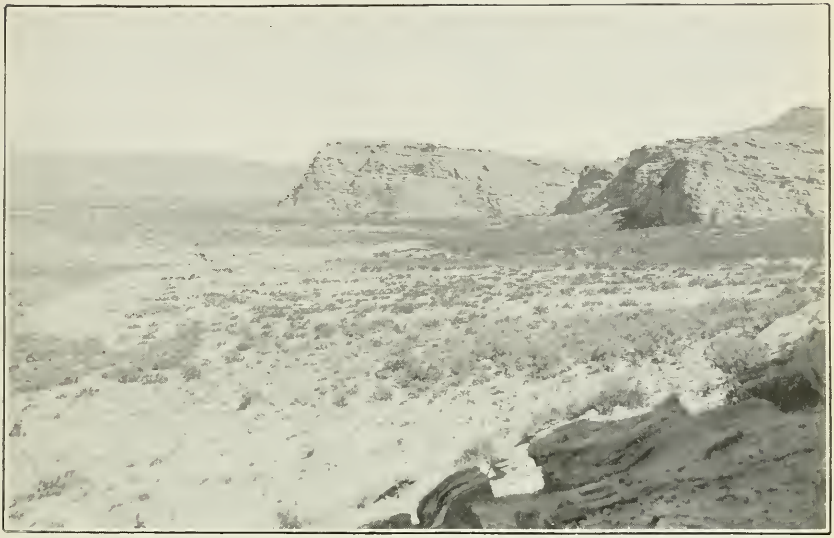


FIG. 1.—POINT OF ROCKS, BITTER CREEK VALLEY, WYOMING.

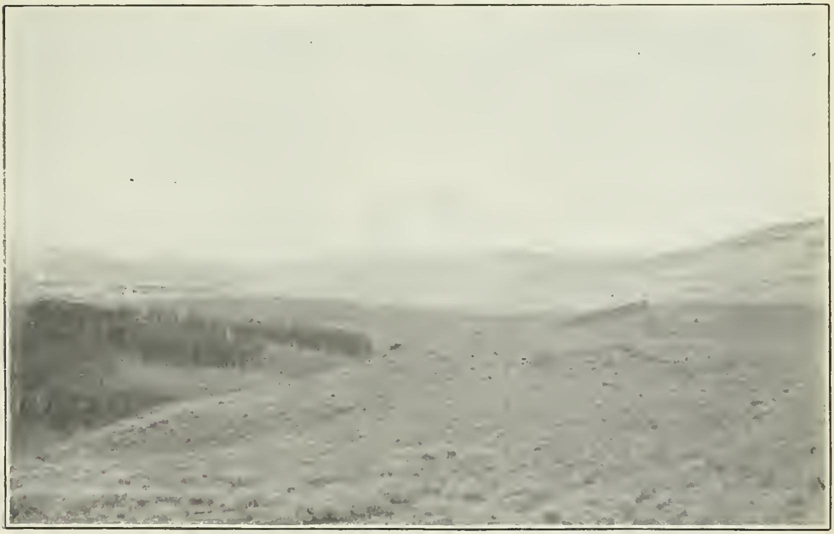


FIG. 2.—THE IDEAL SUMMER RANGE. WYOMING.

pogon, *Sporobolus*, and *Triodia* in October. If these grasses are killed out, their places will be taken by annuals of weedy proclivities, such as the numerous species of *Eragrostis* and *Aristida*, which are neither lasting nor nutritious—grasses that spring up with the early summer rains, ripen an abundance of seed, and die.

ROCKY MOUNTAIN REGION.

CONDITIONS AND PROBLEMS.

Under this heading the work in Colorado, Utah, Wyoming, and Montana will be discussed. The physiographic and climatic conditions throughout this region are extremely varied, and consequently the forage problems are very numerous. The climatic conditions naturally depend largely upon the contour of the country. In the higher altitudes of the extensive mountain regions there is usually sufficient moisture, either in the form of rain or snow; hence the mountain pastures and meadows do not suffer much from drought. In the foothills, broad valleys, and more or less elevated bench lands the conditions are more unfavorable for the development of vegetation, as the amount of available moisture is much less. The flood plains and bottom lands along the rivers and larger streams have been settled and placed under irrigation and produce abundant crops. The greater portion of the unirrigated areas of this region is used for grazing. The problems met with here are as numerous and varied as the soils and climatic conditions, and their great importance can be appreciated when it is known that the greater part of this country will probably never be profitably used for other than grazing and forestry purposes on account of the physical features and unfavorable climatic conditions. The importance of the problems here was early recognized and steps taken toward a thorough investigation of them. The range lands, owing to injurious treatment, were rapidly deteriorating and their carrying capacity was much lessened. With the rapid increase in population and number of stock there arose a demand for hay for winter feed. There was also the question of forage crops that might be successfully cultivated on the arid soils, which were so situated as to make irrigation impossible. These extensive areas of alkali soils presented various questions as to the possibilities of growing forage plants. The injurious methods of irrigation had also resulted in the, at least temporary, ruin by seepage of some of the best of the valley lands. The various subalpine meadows were also in need of improvement. The scanty amount of available knowledge of the forage and actual condition of affairs over the greater portion of this region made it particularly desirable to begin a thorough investigation of the various problems presenting themselves. The inaccessibility of a large part of the country made field work here more difficult and expensive than in many other regions, as the work could only be successfully carried on by extended trips overland.

WORK DONE.

The work here was commenced in the season of 1895 by Mr. P. A. Rydberg and the writer. Only a general survey of the region was attempted, as it was considered desirable to first secure a knowledge of the main features of the conditions and problems as a basis for more thorough work. During the investigations the following points were visited, beside those in Nebraska which have been referred to in discussing the Great Plains region: Green River, Wyoming; Beaver Canyon, Idaho; Lima, Red Rock, Dillon, Melrose, Silver Bow, Deer Lodge, Garrison, Helena, Townsend, Logan, Manhattan, Bozeman, and Butte, Mont.; Logan and Echo, Utah; Denver, Golden, Idaho Springs, Georgetown, Silver Plume, Boulder, and La Salle, Colo. The results of this work were published in Bulletin No. 5, "A Report upon the Grasses and Forage Plants of the Rocky Mountain Region." The following lines of work were given especial attention: First, making a collection of all the grasses and forage plants met with and taking notes regarding their abundance, distribution, forage value, and probable adaptability to cultivation; second, an examination of the meadows and ranges as to their present condition and the securing of all possible information regarding their former condition. A large collection of seeds, sheaves, and roots was also made. The number of specimens secured was over 4,000, among which were grasses which had not before been collected or described.

Under the head of "Field notes and general observations" the various places visited were discussed and the more important grasses mentioned. Under the head of "Grasses deserving special mention" a list was given of the most important native species, with notes on their characteristics and the particular uses to which they were best adapted. The great importance of many of these species was indicated and the desirability of introducing them into cultivation was pointed out.

During the same season Mr. E. R. Chase did some field work for the Division in Utah, at Brigham City and vicinity. He gave special attention to the possibilities in the way of cultivating the native grasses and forage plants and the collection of seeds and sheaves of the more important species.

In 1896 the work in this region was extended and vigorously pushed. Mr. P. A. Rydberg continued the work in Montana. Equipping himself with a camping outfit at Bozeman, in the southern part of the State, he made an extended trip overland through the mountain regions to the northward, making an especially careful study of the forage resources of the region. He made a large collection of specimens and seeds, with notes on the conditions and problems.

It is only by the careful work which can be done by this method of traveling that a thorough study can be made of the actual condition

PLATE XI.

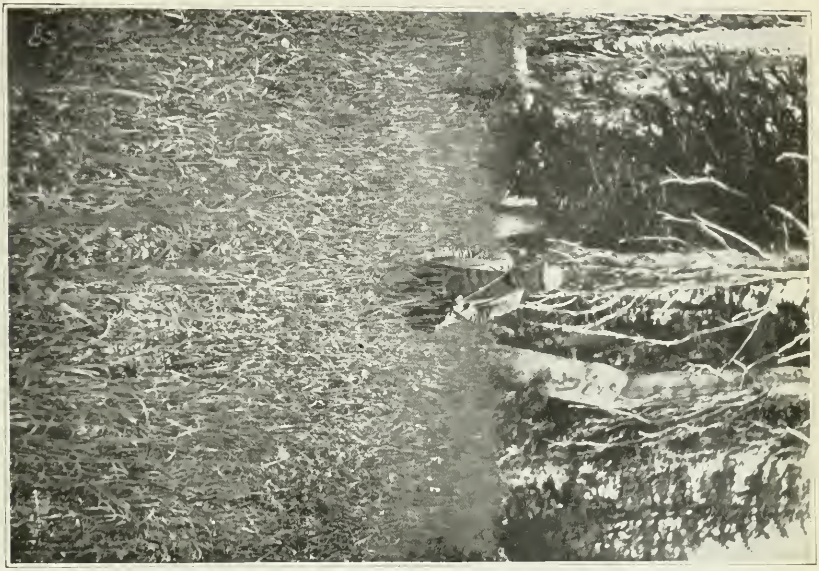


FIG. 1.—MOUNTAIN RYE GRASS (ELYMUS GLAUCUS). AN EXCELLENT GRASS ADAPTED TO HIGH ALTITUDES.

From a photograph by C. L. Shear, taken at Buffalo Pass, Colorado, altitude, 10,000 feet.

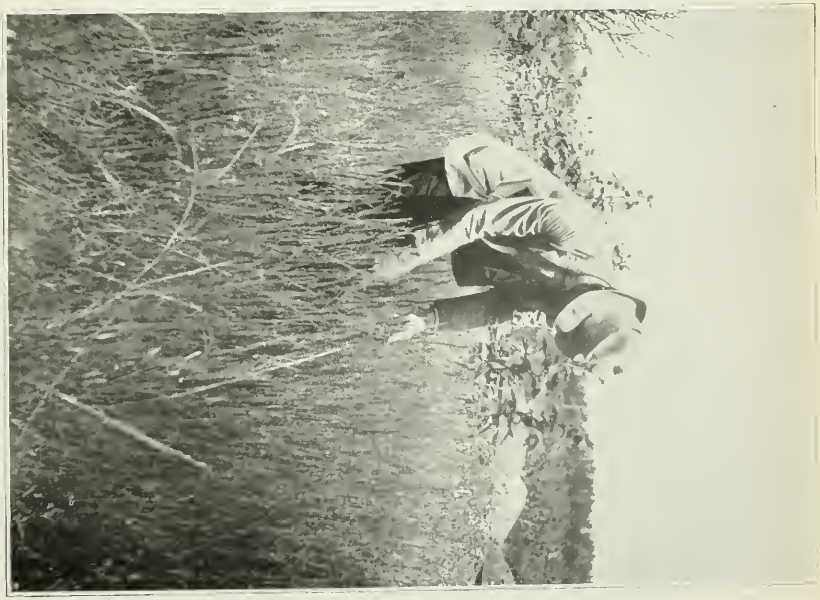


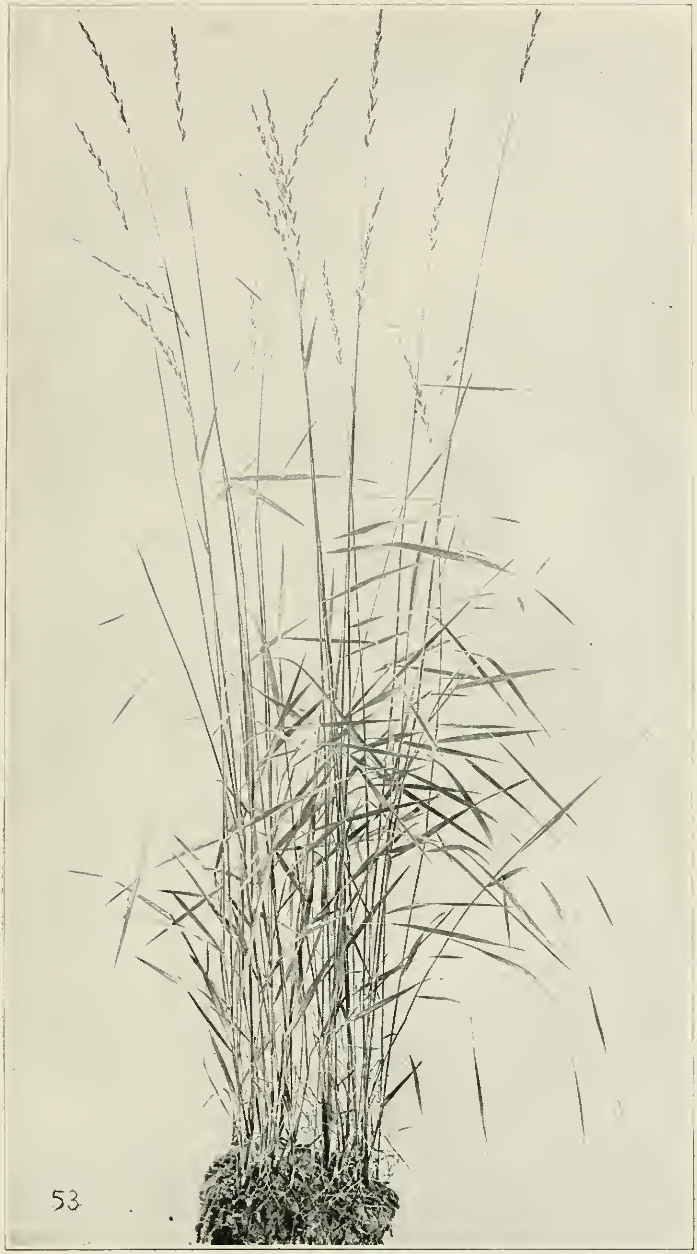
FIG. 2.—SIDE OATS GRAMA (BOUTELOUA CURTIPENDULA). AN IMPORTANT HAY AND PASTURE GRASS OF THE GREAT PLAINS.

From a photograph by C. L. Shear, near Rocky Ford, Colo.

of the various portions of the range and its forage resources. In this way the field worker comes into direct contact also with the ranchers and stockmen and secures at first hand information regarding previous conditions and treatment of the ranges, and also the views of these persons as to the best method of meeting the problems presented. During the same season Mr. F. E. Clements and the writer spent nearly three months working in Colorado. As the results of this work have never been published, it may be best to give an outline of the work done and the results accomplished. Work was commenced in the Pike's Peak region in the vicinity of Colorado Springs. The forage plants of the region were collected and notes taken regarding their abundance and value. The range lands on the mesa and in the mountains were investigated. As a result of the prevailing arid conditions and overstocking, the pastures on the mesa and in the foothills are very poor. The most important grasses are the grama grasses (*Bouteloua oligostachya* and *B. hirsuta*), the first being the most abundant and important, as it is about the last to succumb to harsh treatment. As the better grasses are destroyed their places are largely occupied by species of less value and of weedy proclivities, such as little drop seed (*Sporobolus depauperatus*) and the triple awns (*Aristida* spp.). Some areas of excellent mountain pastures are to be found in the higher altitudes, especially in the vicinity of Seven Lakes. The bulk of the forage here consists of sheep's fescue (*Festuca ovina*), with occasional small areas of tufted hair grass (*Deschampsia cæspitosa*) and alpine timothy (*Phleum alpinum*). In the wetter portions about the lakes species of *Carex* and *Eleocharis* predominate. The greater portion of the timbered areas and open mountain sides in this vicinity produce very little forage.

The next point visited was Walsenburg. The soil on the plains here is rather sandy. The whole region was formerly an immense cattle range, which has been largely abandoned during recent years. Here as elsewhere the prevailing and most important pasture grass is the blue grama. It is very thin and scattered, however, owing to the overstocking of the pastures, which has been carried on until recently. If given proper opportunity to recover, there is little doubt but that this grass will rapidly spread and largely restore the range. A considerable number of other species occur in the thickets along the borders of streams and cultivated lands, but not in sufficient quantity to be of much economic importance. In the vicinity of the alkali lakes near Walsenburg, alkali meadow grass (*Puccinellia airoides*) is rather abundant, and furnishes considerable forage, though it is not so well liked by stock as many other grasses. It possesses, however, alkali resistant qualities, which enable it to grow in soils which better grasses can not endure. The work was continued up the valley of the Cuchara to La Veta, where there are some excellent meadow lands. A good opportunity was afforded here to note the effect of a slight increase in the supply of moisture upon the native grasses, as many of the native meadows here are under irrigation. Several of the wheat grasses and rye grasses (*Agropyron* and *Elymus* spp.) grow luxuriantly; also the gramas and the manna grasses (*Bouteloua* and *Panicularia* spp.) (Pl. VIII, fig. 1). Continuing westward, the mountain range lands in the vicinity of Veta Pass were visited. As overstocking has not been carried on here, at least to any great extent, in recent years, the pasture lands are in very fair condition. On the open mountain slopes several bunch grasses are quite abundant, especially the fescues. One species in particular, Thurber's fescue (*Festuca thurberi*), grows very luxuriantly here. This, besides its value for pasture, gives great promise for cultivation. A small area of it has been grown in the grass garden at Washington, and it has shown itself readily adapted to cultivation. Efforts have been made to secure a sufficient quantity of seed to experiment with more extensively, and it may ultimately prove superior to the meadow fescues for cultivation, especially in the more arid regions. Western brome (*Bromus pumpellianus*) is also found in considerable quantity in Veta Pass and vicinity. Species of blue grass, wheat grass, and rye grass also occur frequently, and furnish excellent forage.

The San Luis Valley was next visited. The greater portion of this valley is a great arid plain, covered over the major part with sage brush (*Artemisia* sp.) and buck brush (*Bigeloria* spp.). Some portions are irrigated from artesian wells as well as by water taken from the Rio Grande. There are extensive alkali areas on which salt grass (*Distichlis spicata*) is very abundant. Over the greater portion of the range land the grasses are few and scattered. Slender wheat grass (*Agropyron tenerum*) was originally described and named from specimens collected in this valley in the vicinity of Garland, and it is a species of considerable economic importance here as elsewhere in Colorado. After studies and collections had been made at Garland, Alamosa, and Villa Grove, the mountain meadows and pastures about Marshall Pass were visited. The condition of the range here, as well as of the forage plants, is very similar to that of Veta Pass. The range here has apparently not been overstocked to any great extent, and its carrying capacity therefore not materially diminished. The comparative inaccessibility of these higher mountain pastures prevents their being ranged over so extensively as the more accessible range lands of the lower altitudes. Many valuable species of native grasses occur here and grow in great luxuriance, especially in the immediate vicinity of the low lands and wet meadows. Blue grasses, bromes, rye grasses, and wheat grasses predominate. Passing from Marshall Pass to the Gunnison Valley, considerable areas of native meadow lands are found along the streams, and these produce abundant crops



WESTERN WHEAT GRASS (AGROPYRON OCCIDENTALE). A VERY IMPORTANT NATIVE HAY AND PASTURE GRASS IN THE GREAT PLAINS AND ROCKY MOUNTAIN REGIONS.

of excellent hay. The mesas, foothills, and mountain slopes, however, are very sparsely covered with forage plants. After short stops at Salida and Canyon City, a trip was made to the Wet Mountain Valley. This region has been favorably known for many years on account of the quantity and quality of native hay produced. The meadows here, by long continued cutting, have become far less productive than formerly. Native meadows extend along Grape Creek for 10 or 15 miles, averaging in width from 1 to 2 miles. The quality of the hay produced is somewhat inferior on account of the presence of sedges, rushes, and similar plants which occupy the wetter portion of the meadows. Judicious draining of certain portions of these meadows and permitting the grasses to seed themselves occasionally would no doubt greatly improve both the quantity and quality of the product. Work was also done in the vicinity of Twin Lakes, where there are considerable areas of swampy meadow lands producing chiefly sedges. Passing over the mountains into the Blue River Valley, an examination of the alpine and subalpine meadows and pastures was made on Mount Bartlett, near Robinson. On the slopes of the higher mountains in this vicinity, above timber line, quite extensive areas of excellent pasture lands occur. These are chiefly used for sheep grazing. Sedges, short-leafed fescue (*Festuca brachyphylla*) and blue grasses furnish most of the grass forage. There are quite a number of other native herbaceous plants, however, which furnish a considerable amount of feed and are relished by sheep. The sheep grazing here does not seem to be carried on in such a manner as to do injury to the range or to the timber land. The sheep are fed here only a short portion of the year, and then not usually in large enough numbers to do any serious harm.

Further study of forage conditions was made at Dillon, Breckenridge, and Como, the latter place being situated in the northwestern portion of South Park. South Park has long been noted in Denver and other local markets for the excellent quality of its wild hay. In the lowlands of the park there are extensive wild hay meadows quite similar to those of Wet Mountain Valley. A considerable portion of the hay produced here consists of *Juncus balticus*. This is generally called "wire grass," though of course it is not a true grass at all. It is very highly prized for hay, and brings a better price on the Denver market than any other hay. As a result of the work in this portion of Colorado, a very large and valuable collection of the grasses and forage plants of the region was secured, some of which proved to be new. A knowledge of the exact conditions of the different range and meadow lands was ascertained, and the relative value of the different grasses and forage plants determined. Seeds, roots, and sheaves of the more important grasses were secured. Fortunately most of the meadows and range lands of the areas just described have not been so badly injured but that a period of rest would largely restore them to their original vigor and carrying capacity.

Prof. L. H. Pammel also did work in central and northern Colorado during the summer of 1896. His investigations were carried on in the vicinity of Fort Morgan, Greely, Fort Collins, Golden, Denver, and Colorado Springs. The results were published in Bulletin No. 9 of this Division, which has already been referred to in connection with the field work in Nebraska and Iowa. In this report the forage plants and conditions of this portion of Colorado are discussed. The chemical composition of a number of the most important native species is given, showing that they compare very favorably with the cultivated grasses. In referring to the importance of improving the native species for cultivation, we may quote the following:

> If by selection from the native grasses an improved form of western wheat grass or grama grass can be introduced into the semiarid regions, it will give greater returns than any of those already there, the live stock industry will be put on a better basis, and its success assured.

In 1897 Prof. Aven Nelson, of the Wyoming Agricultural Experiment Station, made a special study of the Red Desert of southern Wyoming and its forage resources. This region covers more than 11,000 square miles. It is a high, undulating plain or plateau, averaging from 6,000 to 7,000 feet elevation (Pl. IX). The water supply is so limited and of such a poor quality that very little of the land can be used for cultivation, consequently it is distinctly a stock region. During the summer season it affords very little in the way of forage, hence it is used almost entirely as a winter range. Professor Nelson says:

> From the 1st of June to the 1st of November the region is practically devoid of stock of all kinds. With the coming of the snows the herds and flocks are worked back into the desert from the summer pastures in the hills and mountains. Through the winter and spring months thousands of head feed upon this rough forage, snowdrifts furnishing the water for all. The sheep herder in his wagon, also dependent upon the snows, guides his flock from district to district as new pasturage is needed. By the time the stock is taken to the summer range the desert is barren indeed. Grasses, sagebrush, salt sage, white sage, rabbit brush, and even cedar, have been grazed so closely that every edible sprig is gone.

In the report from which the above quotation is made (Bulletin No. 13, Division of Agrostology, "The Red Desert of Wyoming and its Forage Resources") Professor Nelson gives a thorough description of the forage problems of this interesting region, both from a scientific and economic standpoint. The topography, geology, soil, and climate are discussed. The soil over the greater portion of the desert is nearly all impregnated with alkali. Analyses of samples of soil taken from various localities show from 0.12 per cent to 7.20 per cent of water-soluble salts. This does not, however, represent the largest amounts

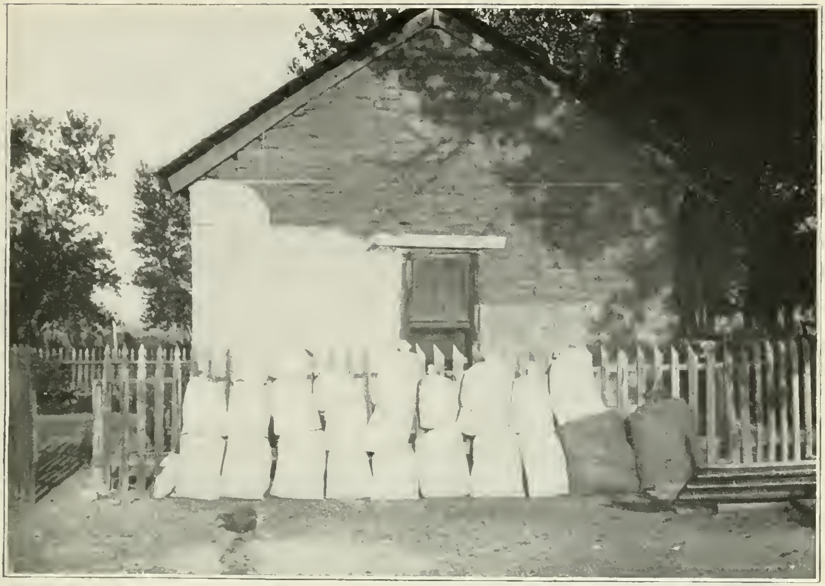


FIG. 1.—SEED OF NATIVE GRASSES, THE RESULT OF TWO DAYS' COLLECTING NEAR CHICO, COLO.

From a photograph by C. L. Shear.

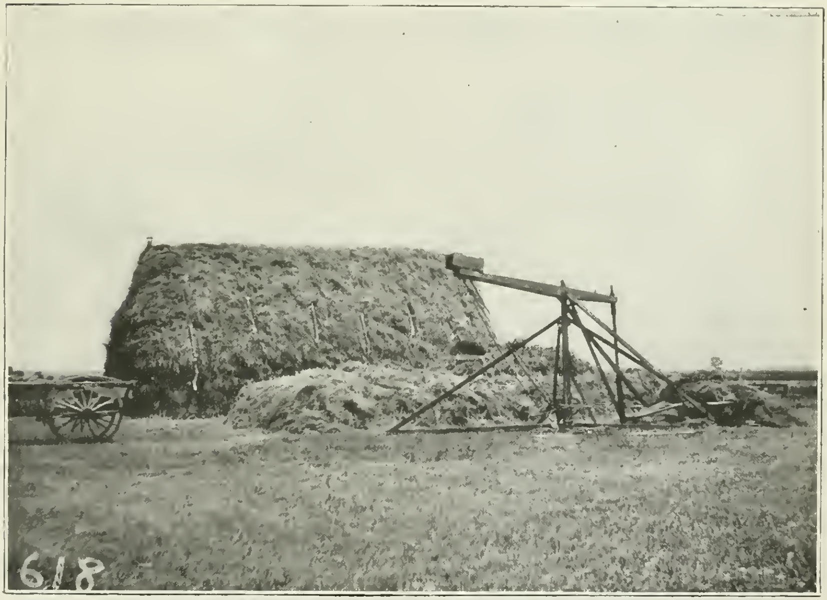


FIG. 2.—STACK OF WILD HAY, SHOWING METHOD OF STACKING.

From a photograph by C. L. Shear, near Chico, Colo.

of alkali that are found. In the bed of a dry pond a species of *Scirpus* was found growing where the surface soil contained more than 60 per cent of soluble salts. Very little of this alkali is what is known as "black alkali," the greater portion of it being what is called "white alkali," of which sodium sulphate is the chief constituent. The bulk of the forage is furnished by saltbushes, sagebrushes, and other plants than grasses. Wheat grasses (*Agropyron* spp.) are most abundant. The amount of alkali in the soil renders the growth of many grasses impossible.

Regarding the present condition of the ranges of this region as compared with the past, we may quote the following:

> According to the most reliable sheep men, the same areas that twenty years ago would only support one sheep will now support from three to five. This they attribute to the gain in the strength of the soil, due to accumulating manure. It seems probable that a more potent factor is found in the following: The vegetation chiefly depended upon for forage is composed of the large number of small shrubs of many kinds previously mentioned. Cutting down to the ground of such vegetation enormously increases the number of annual shoots. From winter to winter this shrubby vegetation has been browsed down closer and closer to the woody bases of the plants, until now the tender annual shoots are produced in much greater abundance. The effectiveness of this browsing is, of course, dependent upon the region being used as a winter pasture only, giving time for growth and recovery each summer.

It will be noted that the improvement which has taken place here affects the shrubby forage plants and not the grasses, and that this improvement is dependent upon the resting of the range land during the greater portion of the growing season. Regarding the native grasses the author says:

> The native grasses also are worthy of trial. The writer has seen wonderful results from seeding the ground to some of these, especially the wheat grasses, and this, too, where the water used for irrigation was far from the best and the ground strong with alkali. Furthermore, the increase in the water supply is not quite hopeless. The region contains many natural basins in which, by the expenditure of a little labor in the construction of dams, much of the water from the accumulated winter snowdrifts might be saved for use later in the season.

In addition to the subjects already mentioned, descriptions and notes regarding the forage value of the various saltbushes (*Atriplex* spp.) and sagebrushes (*Artemisia* spp.) are given. There is little doubt that some of these plants will prove worthy of cultivation. Seeds of many of them have already been secured and experiments commenced to demonstrate their value under cultivation in arid and alkali soils. Descriptions of the grasses of the range are also given, with full notes regarding their value and the best methods of increasing their production. Besides the Red Desert proper, an investigation was also made of the foothills and mountains which furnish grazing for stock during the summer season (Pl. X, fig. 2). The forage here consists much more largely of grasses, the most abundant and valuable of which are discussed. Besides a complete list of the forage plants of the summer range, a systematic list, with notes on all the plants collected in the Red Desert, is given.

Other work in the Rocky Mountain region was carried on in 1897 in southwestern Colorado by the writer, assisted by Mr. A. Selig, and by Messrs. Williams and Griffiths in the Big Horn Mountains of Wyoming, and in southern and western Montana. The results of this field work, as well as of all that upon which nothing had been published previous to 1898, were combined by Mr. Williams in Bulletin No. 12 of this Division, under the title "A Report upon the Grasses and Forage Plants and Forage Conditions of the Eastern Rocky Mountain Region." From the author's own extensive work in this region and from the reports and work of field agents it was possible to obtain a better grasp of the forage conditions and problems of this region than had been done heretofore. In the introduction the great importance of the stock-raising industry is referred to and the growth of interest in the various problems connected with it. Besides the information derived from field work undertaken by employees of this Division, much was secured from prominent stockmen, farmers, and others familiar with the problems by a circular letter of inquiry. Answers to this were received from about six hundred persons. These answers show how varied are the forage problems of the region. At one place it is early spring forage that is most needed, at another there is a lack of winter forage, and at another it may be summer feed. Under the heading of "General topographical features of the region," the great amount of variation in the physical character of the country is pointed out. A description of the soil follows, and also of the water supply. Under the heading of "Present aspect of the forage problem," the important questions which present themselves are discussed, and the causes and conditions which have led to the present troubles are pointed out. Unfavorable seasons and the destruction of the forage by over-stocking made it necessary for stockmen to provide feed in order to carry the herds safely through the winter. Many, however, did not attempt anything in this direction until compelled to do so by very serious losses. Thus one of the great needs of this region is a hay plant that will endure the arid conditions and alkali soils and produce profitable crops. Of course in localities where there are facilities for irrigation alfalfa can be very successfully grown. But alfalfa, to be used to the best advantage, should be supplemented by some other hay. Alfalfa, also, is restricted to certain altitudes. In Montana it can not be successfully grown at a greater altitude than 4,500 or 5,000 feet, and since about one-half of the area of the State lies above this limit it will be seen that some other hay plant is needed to meet the requirements of a large portion of this State. As we go farther south, the limit of successful growth

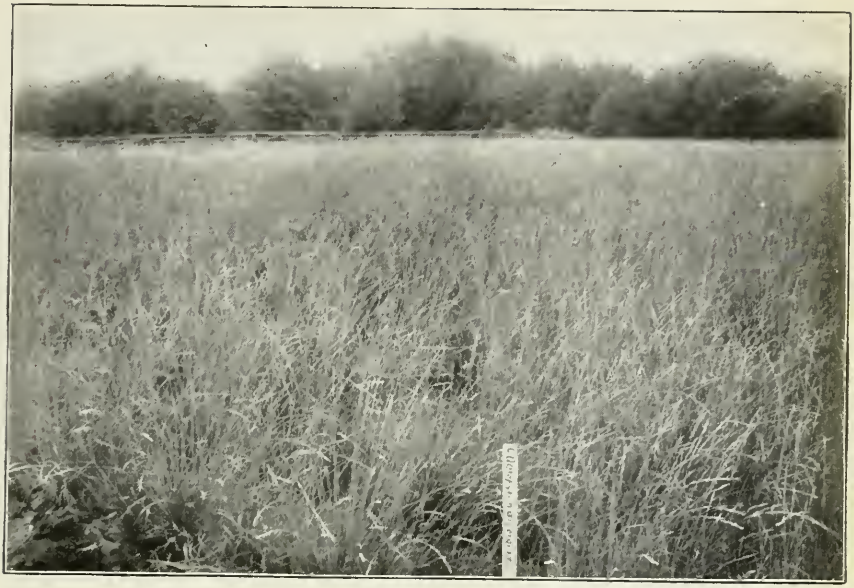


FIG. 1.—BUNCH WHEAT GRASS (AGROPYRON SPICATUM RYDB.). UNITED STATES GRASS STATION AT WALLA WALLA, WASH.

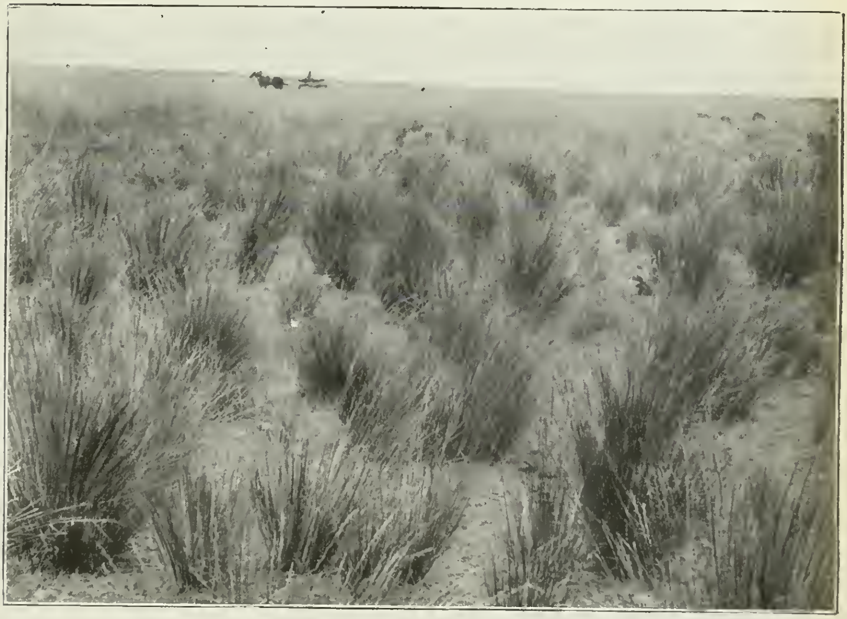


FIG. 2.—BUNCH WHEAT GRASS (NATURAL GROWTH), OREGON.

From a photograph by A. B. Leckenby.

is higher. In the southern part of Colorado it can be profitably grown at an altitude of 7,500 feet, but there are still large areas of suitable lands throughout this region lying at too great an altitude to grow this crop. In this case, as in that of the arid and alkali soils, the solution of the problem is believed to be found in the cultivation and adaptation of the native grasses and forage plants. For the higher altitudes there are several blue grasses (*Poa* spp.) which produce hay of excellent quality. Other excellent species for these localities are species of *Bromus*, especially western brome grass (*Bromus pumpellianus*) and short awned brome grass (*Bromus marginatus*). Various species of blue-joint (*Calamagrostis* spp.) Alpine timothy (*Phleum alpinum*), western foxtail (*Alopecurus occidentalis*) and red fescue (*Festuca rubra*) are all valuable meadow grasses, which produce good forage at altitudes too high for the production of any of the cultivated species. After a description of the forage conditions on the range of western South Dakota and north-eastern Wyoming, consisting of an abstract from the report of Mr. Griffiths for 1897, the cultivated grasses and forage plants which have been tried or give indications of success in this region are fully described, and their particular characteristics and adaptability to particular conditions pointed out. The native grasses and forage plants are also discussed. In referring to the native grasses Mr. Williams says:

> The great economic importance of the native grasses is at once apparent when one recalls the many thousands of sheep, cattle, horses, and mules that are raised in this region, and that depend entirely upon the native grasses and forage plants for subsistence for from eight to twelve months in the year. That the quality of the forage afforded is excellent is shown by the fact that most of the vast numbers of fat cattle and sheep annually shipped to eastern markets from this region received no other food than that furnished by the natural meadows and pastures of the ranges.

The more important native grasses are arranged for purposes of discussion in two groups, meadow grasses and pasture grasses. Of the native meadow or hay grasses the great value of the wheat grasses (*Agropyron* spp.), the rye grasses (*Elymus* spp.), and the blue grasses (*Poa* spp.) is pointed out. The native pasture grasses are treated of under two subheads, "Grasses of the plains" and "Grasses of the foothills and mountains." The grasses of the plains referred to here are those which we have already discussed in dealing with the plains region. The grasses of the foothills and mountains are numerous and consist largely of bunch grasses. Sheep's fescue (*Festuca ovina*), bunch wheat grass (*Agropyron spicatum*), needle grasses (*Stipa* spp.) are abundant and of great value. There is nothing to indicate that these grasses may not be successfully cultivated. In fact, experiments already undertaken with some of them have shown that they adapt themselves readily to cultivation, and there is little doubt that in the near future seeds of these species will be grown and the plants regularly cultivated in this region. The native clovers, vetches, and lupines, as well as rushes, sedges, and other miscellaneous native forage plants, are also given considerable attention. The number of plants in this region, which have a greater or less degree of importance as forage plants, is particularly large, and there is no apparent reason why, by proper preservation and care of the natural forage resources, there should not be produced an abundant supply for all present needs.

The bulletin closes with a chapter on "Improvement of the ranges," in which the necessity of establishing some system of control, which shall allow each person the exclusive right to graze his stock on a given piece of land, is emphasized. Some of the evils of the present system, or rather lack of system, in the management of the free range are indicated. The importance of the conservation of the rainfall is also mentioned, and the desirability of providing reservoirs or tanks at convenient intervals for supplying stock with water, thus avoiding the necessity of their tramping long distances is pointed out. In speaking of the desirability of experimenting with grasses, for the purpose of selecting and securing varieties adapted to the different soil and climatic conditions of this region, the following advice is given:

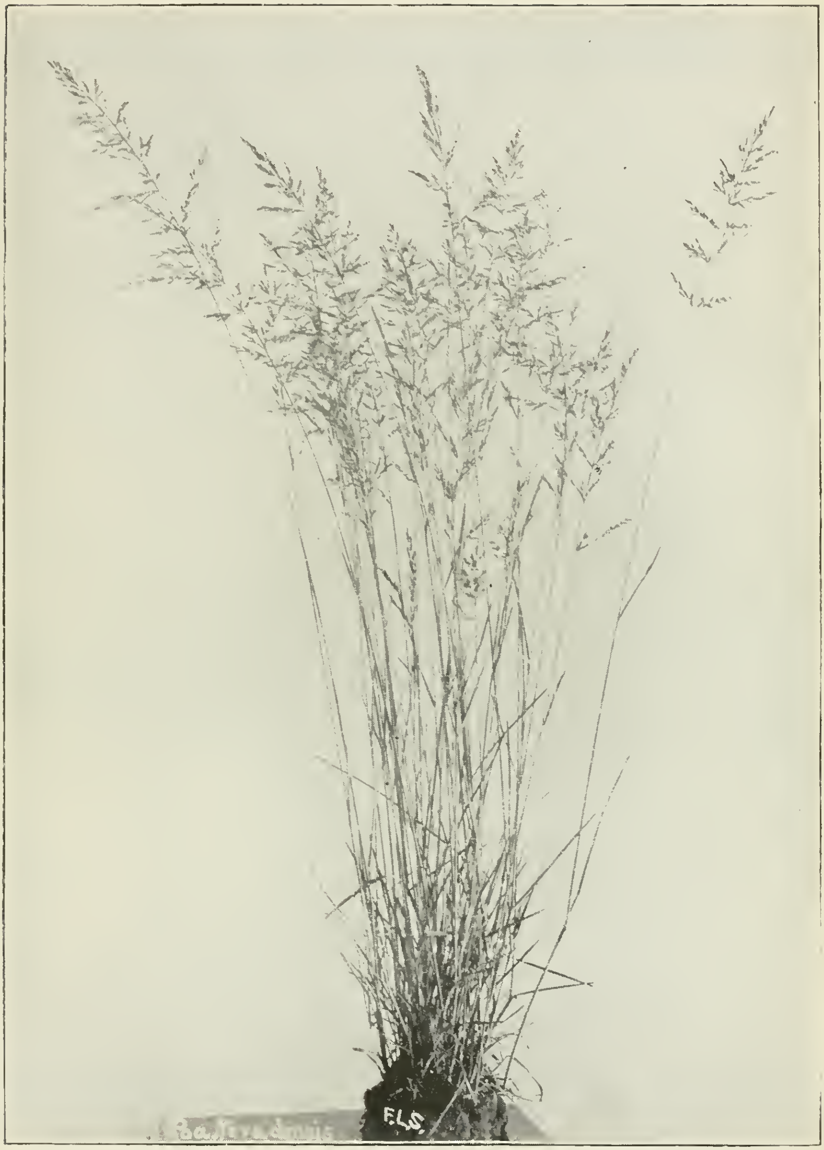
> These experiments should not be confined to the tame or introduced sorts, but should be extended to desirable native kinds, such as have been mentioned in the preceding pages. There is no locality without grasses or forage plants worthy of trial under cultivation, and when one can, with but little trouble, obtain enough seed for such a test.

As a means of restricting the ranges in case the grasses have not been too largely exterminated a period of rest is recommended. This gives the grasses opportunity to produce seed and regain their vigor. The great value of disk harrowing and also of alternate grazing is mentioned.

In 1898 the writer, accompanied by Mr. Ernst A. Bessey, made a thorough investigation of the grass and forage condition of northern Colorado. A team and camping outfit were secured at Wolcott, on the Denver and Rio Grande Railroad. From this point we proceeded northward on the road to Steamboat Springs. Stops were made at various points, collections of the various grasses and forage plants were made, and much information regarding range conditions and management secured. In the Bear River Valley, between Yampa and Steamboat Springs, there are considerable areas of meadow lands, which produce, in favorable seasons, large crops of excellent hay. The most prominent grasses are the blue grasses, especially *Poa lævigata*, hair grass (*Deschampsia cæspitosa*), sheep's fescue (*Festuca ovina*), alkali meadow grass (*Puccinellia airoides*) and wire grass (*Juncus balticus*). Considerable alfalfa is grown for winter feed at this altitude.

From Steamboat Springs we continued east, crossing the Park range and investigating the mountain pastures and meadows. Near

PLATE XV.



NEVADA BLUE GRASS (POA NEVADENSIS). AN IMPORTANT NATIVE GRASS IN THE NORTHWEST.

Photographed from plant grown at Washington, D. C., by F. Lamson-Scribner.

the summit of the divide and over extensive areas in the more open timber land mountain rye grass (*Elymus glaucus*) occurred in abundance (Pl. XI, fig. 1). This grass is a most excellent one for hay, and as it grows naturally at an altitude of eight to ten thousand feet, is likely to prove of great value for cultivation in such localities. The grass is one deserving of attention, and from past experience with the native rye grasses it seems probable that there will be little difficulty in cultivating it. Seed of it has been secured, and experiments in growing it are being carried on at present in various places. A species of blue grass (*Poa wheeleri*) also grows at this altitude and gives promise of great value for cultivation. Passing from the mountains to North Park work was done in the vicinity of Higho, Lake John, and Hebron. The general elevation here is about 9,000 feet. In the bottom lands along the streams there are many wild hay meadows. Some of them, however, are badly infested with squirrel tail (*Hordeum jubatum*). This grass is becoming a great nuisance throughout this region, and steps should be taken to destroy it. As it matures before the other grasses are ready to cut, its seed become widely distributed. If, however, it were mown before any of the seed had matured, it could be controlled without great difficulty and at the same time be used for hay. Here on the mesa was also found, in small quantities, blue grama. This altitude (9,000 feet) is the highest at which this valuable grass is known to grow. The various wheat grasses form an important part of the forage on the mesa. Wire grass (*Juncus balticus*) and various sedges constitute a considerable portion of the hay, especially in the wetter parts of the meadows. From North Park the work was continued over Muddy Pass and through Middle Park to Grand Lake, then over the Sheephorn Divide and down the valley of the Grand River, returning to Wolcott.

The carrying capacity of much of the range land of this region has not greatly diminished during recent years. From 15 to 25 acres are necessary to carry one head of stock. More judicious pasturing would, however, increase the carrying capacity of much of this land. As stock must be fed during portions of the winter, more attention should be given to the improvement of meadows and the growing of hay. Much of the region is situated at too great an elevation to successfully grow alfalfa. There are, however, several of the native grasses which with proper attention would produce excellent crops of hay. The wheat grasses, western wheat grass (*Agropyron occidentale*) (Pl. XII), slender wheat grass (*Agropyron tenerum*), short-awned brome (*Bromus marginatus*), and the rye grasses, Macoun's rye grass (*Elymus macounii*) and mountain rye grass (*Elymus glaucus*) are adapted to the conditions prevailing here. Seed of these could be collected without great difficulty and sown upon the natural meadow lands to great advantage.

All the land which lies along the water courses has been taken up and fenced and is largely in the possession of a few owners, who from their ability to control the water supply naturally control the use of all the adjacent range lands, as no stock can be kept on the range without a sufficient water supply. Not only this, but in many cases the public range lands themselves have been fenced, thus excluding all other people from placing stock on the land. This very evident injustice is the quite logical result of the lack of any system of controlling the public lands. The grazing lands of Colorado vary greatly in their carrying capacity and condition. From the work which has been done by the Division, not only through personal investigation but by letters of inquiry from various stockmen throughout the State, it appears that while in some localities the ranges are in nearly as good condition as formerly, in others the carrying capacity has been diminished as much as 50 per cent or even more. It is believed that an estimate of an average of 25 per cent decrease in the carrying capacity for the State as a whole would be a fair statement of the case.

No field work was done in this region in 1899, but in 1900 work was carried on at several points. Dr. David Griffiths and Mr. E. F. Lange worked in Montana; Professor Scribner and Mr. E. D. Merrill in Idaho, Wyoming, and the National Park; Mr. Elias Nelson, in southern Wyoming; and Mr. William Shear and the writer in southern Colorado. The work previously done here had been sufficient to afford a very good general knowledge of the forage plants and conditions as well as the most important problems and requirements. Recognizing that, to secure grasses and forage plants capable of succeeding under the unfavorable conditions of soil and climate prevailing over a large portion of the region, very little was to be expected from the introduction of tame grasses, which were only adapted to growth in moister regions; our efforts were directed toward the grasses and forage plants native to the region. As has already been pointed out, there is a considerable number of most excellent grasses native here, and it was deemed desirable to make an effort to introduce these species into cultivation. With this aim in view the chief object of the field work this year was to secure large quantities of seeds of the best native grasses and forage plants. In cases where seed could not be well secured or the plant was most easily propagated from roots these were secured. A considerable collection of specimens was also made incidentally. The results of the work have already been published by the writer in Circular No. 9 of the Office of the Secretary. Much interest was shown in the work by stockmen and ranchmen of the region visited, and expressions of appreciation and encouragement as well as assistance were given. In regard to the results of this season's work we may quote the following from the report referred to:

> As a result of the work in the field this summer seeds of about 130 varieties of grasses and forage plants were secured. These were obtained in quantities varying

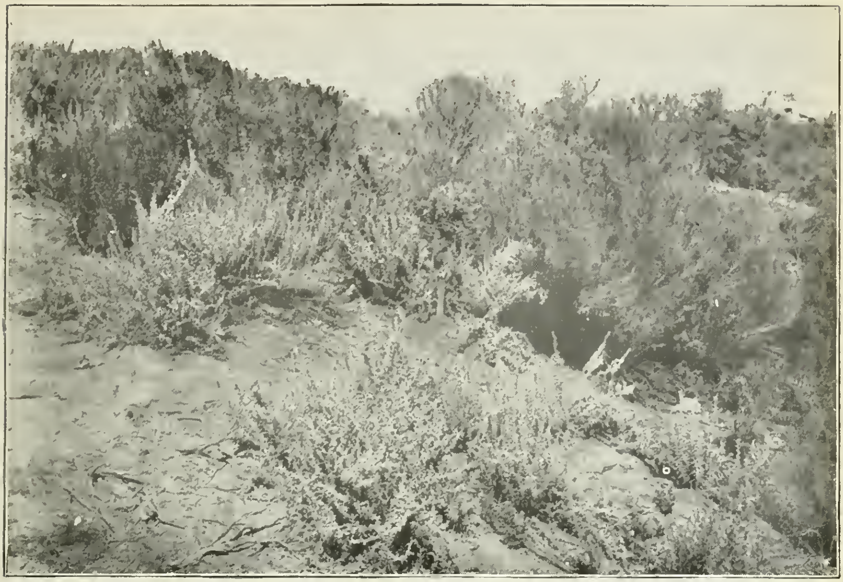


FIG. 1.—WINTER FAT (EUROTIA LANATA). NATIVE GROWTH, PARKER, WASH.

From a photograph by A. B. Leckenby.

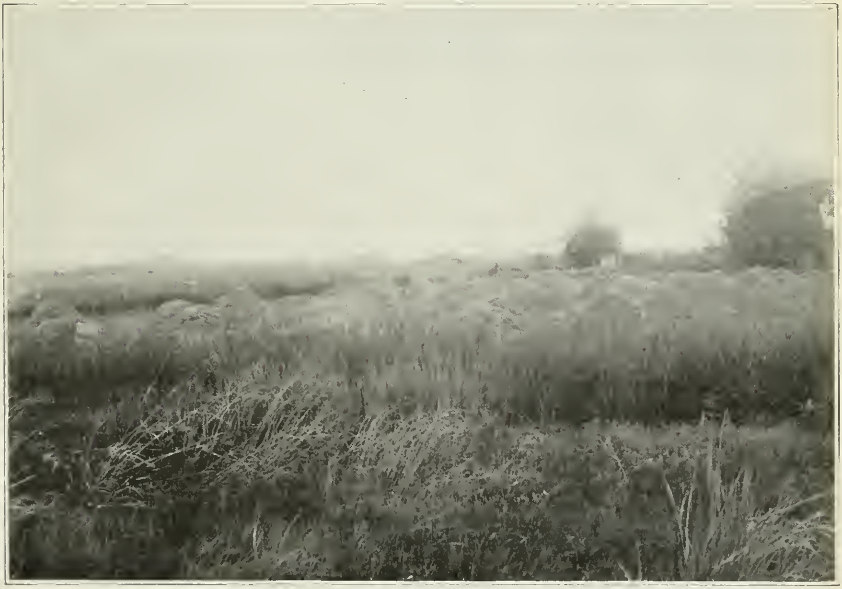


FIG. 2.—A FIELD OF QUACK GRASS HAY (AGROPYRON REPENS), NEAR WALLA WALLA, WASH, SHOWING THE LARGE CROP PRODUCED.

From a photograph by A. B. Leckenby.

from one to five hundred pounds, according to the desirability of the species and the difficulty of securing it. The total amount collected was about 4 tons. Besides seeds a considerable quantity of roots were obtained for transplanting, also several hundred specimens of interesting species for the herbarium or exhibition purposes. Among the most important results of the field work was the information secured by direct observation of the actual conditions and problems to be met in the various regions and by intercourse with the stockmen and ranchmen. This intercourse brings into actual touch the Department and those for whose immediate benefit the work is intended, and so promotes mutual understanding and profit. They come to a better understanding of the methods and aims of the Department, and we come to a better knowledge of their difficulties and needs.

The value of this seed work and the desirability of continuing it was particularly emphasized. The little experience already gained by the cultivation of some of the native forage plants has conclusively shown that there are great possibilities in this direction, and that future investigations will undoubtedly prove that many of these native species can be successfully and profitably cultivated in arid and alkali soils where few or none of our introduced species will succeed. A list of the especially promising species of which seed was obtained in quantity was also given in this circular with notes regarding their distribution and their particular value for special conditions and purposes.

THE NORTHWEST.

CONDITIONS AND PROBLEMS.

Under this head the region included in western Idaho and the portions of Washington and Oregon lying east of the Cascade Mountains will be considered. The conditions and problems here are very similar to those of the Rocky Mountain region, especially of the northern portion of that region. The annual rainfall over the greater part of this territory averages about 15 inches or less. The important forage questions presenting themselves are here, as in the Rocky Mountains, the improvement of the greatly deteriorated range lands and the question of forage for arid and alkali soils. In addition there is the question of the control of the shifting sands at various points along the Columbia River.

WORK DONE.

Field work in this region was commenced in 1898 by Prof. F. Lamson-Scribner, who made a general study of the region. Mr. A. B. Leckenby has done work for the division in this region during the past three years, in addition to having charge of the experimental work which was carried on at North Yakima and Walla Walla, Wash. Professor Scribner, Mr. A. L. Scribner, and the writer did work in this region during the summer of 1899. The range lands in the vicinity of Walla Walla and in the Blue Mountains of Washington and Oregon were investigated; also the ranges and sand dunes in the vicinity of The Dalles. The most important native grasses of the range are bunch wheat grass (*Agropyron spicatum* (Pursh) Rydb.) (Pl. XIV) and several species of blue grass (*Poa* spp.) Winter fat (*Eurotia lanata*) is a native forage plant of considerable value here and also in many localities throughout the arid region. The accompanying illustration shows this plant as it grows at Parker, Wash. (Pl. XVI, fig. 1). Persons who have resided in this region for the past twenty-five or thirty years state that the range lands in the vicinity of the Columbia River in Washington and Oregon were in the early days practically covered with a very abundant growth of the bunch grasses. Through overstocking and drought these bunch grasses have been practically exterminated over large areas and their places occupied more or less by weedy annual plants, especially the soft chess (*Bromus hordeaceus*), which furnishes very little forage. Besides cattle, large numbers of horses have ranged over some portions of the country and have done much to bring about the present unfavorable condition of things. Sheep have also done considerable injury in many places. There has been no effort made by the stockmen to conserve the product of the grazing lands, the lack of any right to control them giving them no inducement to improve or care for them. Early in the course of the investigations in this region the great desirability of testing the more promising native and introduced forage crops which gave promise of success in this region was recognized. Two points were selected at which culture experiments were commenced, one at Walla Walla, in connection with the Oregon Railroad and Navigation Company, and the other at Yakima, on land belonging to the Northern Pacific Railway Company. The work here, which was under the immediate supervision of Mr. Leckenby, served to demonstrate very conclusively the possibilities in the way of cultivation and the great value of some of the native grasses, especially the bunch wheat-grasses, which, as before mentioned, occupied a large portion of the range lands of this region. Other wheat-grasses, as western wheat-grass, (*Agropyron occidentale*) and slender wheat-grass (*Agropyron tenerum*) also showed great adaptability to cultivation and give great promise of usefulness in this region. These grasses will grow with little or no irrigation. The blue grama grass (*Bouteloua oligostachya*), though not a native of this side of the range, proved well adapted to the prevailing conditions. The accompanying illustration shows a small field of quack grass (*Agropyron repens*) grown near Walla Walla. It produced an enormous crop with little irrigation (Pl. XVI, fig. 2). Awnless brome-grass, which was also tried here, gave excellent results.

The sand-binding grasses along the Columbia River were given especial attention. Seeds and roots of many of them were collected in quantity for testing here and elsewhere. Experiments in growing them were carried on at different points along the river and some quite

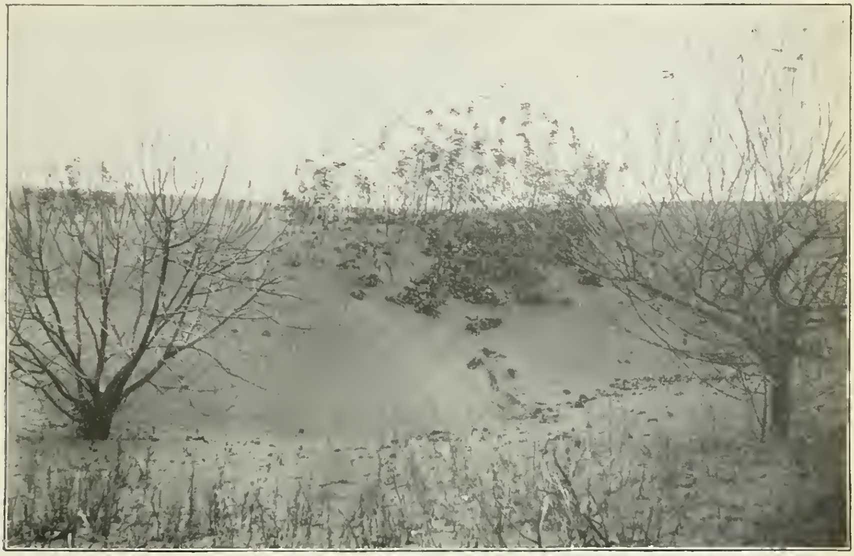


FIG. 1.—SAND DRIFTS ALONG THE COLUMBIA RIVER, OREGON, IN PEACH ORCHARD.

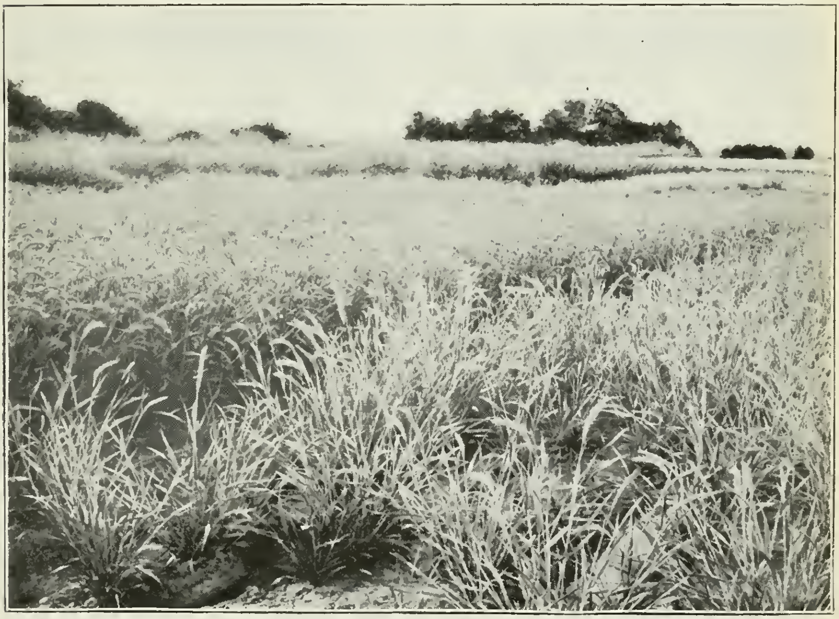


FIG. 2.—VIEW IN GRASS STATION AT WALLA WALLA, WASH., SHOWING CANADIAN RYE GRASS (ELYMUS CANADENSIS).

From a photograph by F. Lamson-Scribner.

encouraging results obtained. The drifting sands along the Columbia, from The Dalles eastward, are a source of great trouble and expense to the railroad company as well as to people occupying the land along the river. The great amount of sand present and the rapidity with which it shifts frequently causes much delay to the railroad traffic, and necessitates considerable expense in keeping the track clear. At some points the sands have encroached upon the cultivated lands, in some instances completely burying orchards and other tracts of valuable land (Pl. XVII, fig. 1). We are told by those familiar with the conditions during the early settlement of the country that there was very little sand along the river, and that it caused little or no damage, but that within recent years the amount of sand brought down by the river has accumulated in greater and greater quantities each year. This large increase in the deposit of sand is no doubt in great part traceable to the deforesting of large areas about the head waters of the Columbia River and its branches, and also to the destruction of much of the plant covering of the hills and mountains by overstocking, thus giving an opportunity for the rainfall to run off rapidly, causing great erosion and carrying large quantities of soil and sand down the streams. Large amounts of sediment are also the product of the mining industries carried on at various points along the Columbia and its tributaries. The lack of a proper covering of the soil which will retain moisture derived from the rainfall and melting snows is also in large part a cause of the excessive floods which have occurred during recent years.

The only publication devoted entirely to the results of work done in this region is circular No. 22, by Professor Scribner, on "Grass and Forage Plant Investigations on the Pacific Coast," in which an outline of the conditions and problems presenting themselves in the region is given, and an account of the experiments carried on at North Yakima and Walla Walla, with especial reference to the native and introduced species which were tried and the degree of success attained. A list was also given of grasses and clovers valuable in the upper Pacific coast region. Besides the large quantities of seed which have been secured, especially of bunch wheat-grass and the wild ryes (*Elymus canadensis* and *Elymus condensatus*), a number of new species of grasses have been collected. *Elymus arenicolus*, *Elymus flavescens*, and *Poa leckenbyi* are new species of important sand-binding grasses which have been found along the Columbia River, and will probably prove of value for introduction into other localities.

In the mountains south of Wallowa Lake, Oregon, we had an opportunity to observe sheep grazing (Pl. XVIII, fig. 1). The effect of the grazing here is apparently not injurious to the timber lands, and where we had opportunity to examine we saw no evidence that it was overgrazed to any appreciable extent. The sheep feed here largely upon the various native plants other than grasses, and are not held long enough in one place to cause any injury. The sheep-grazing industry may be injurious or not, according as it is conducted. In some localities there is evidence that sheep grazing in the forest reservations is conducted in such a manner as to result in great injury to the forests and to the grazing lands, and indirectly to the whole country on account of the inability of the denuded soil to retain the rainfall. We are of the opinion, as already expressed by the Division of Forestry, that sheep grazing under proper restrictions is not necessarily injurious to forest reserves.

THE SOUTHWEST.

CONDITIONS AND PROBLEMS.

It is in this region, which includes western Texas, New Mexico, Arizona, and southeastern California, that the most difficult conditions and problems present themselves. The greater portion of this region presents conditions quite different from those found in any other part of the United States. The most favorable climatic conditions are to be found in central and western Texas. Here the annual precipitation ranges from 25 inches near the center of the State to 15 toward the western border. The greater portion of this part of Texas is excellent grazing land. In fact, there are few areas to be found where the natural conditions are so favorable to stock raising. Considerable change has taken place in the aspect of this country since the departure of the buffalo and Indian, owing to the destruction of bushes, shrubs, and trees, caused by the prairie fires which the Indians are said to have set in order to improve the grazing or which were started accidentally. Very few of these plants survived except in protected situations. As soon as the prairie fires became less frequent the shrubby vegetation spread rapidly, especially the mesquite bean (*Prosopis* sp.). This tree has spread with great rapidity in recent years and now forms a scattered growth over a great portion of central and western Texas as well as throughout the lower altitudes of this whole region (Pl. XIX, fig. 1). The rich and nutritious native grasses and forage plants were exceedingly abundant at the time the stockmen began to bring their flocks and herds to these ranges. The territory was so inaccessible before the coming of the railroads that there was a great abundance of food for all the stock, and the opinion prevailed that the forage resources of the country were inexhaustible. At this time it is said that the grazing capacity of large areas of land was one head of stock to 2 to 5 acres, whereas on these same areas to-day it requires from 10 to 16 acres to carry a single head of stock. The building of the Texas Pacific Railroad in 1883 gave great impetus to the stock-raising industry, which immediately began a rapid development. The grazing being practically free, as no provision had yet been made by the railroads or State for

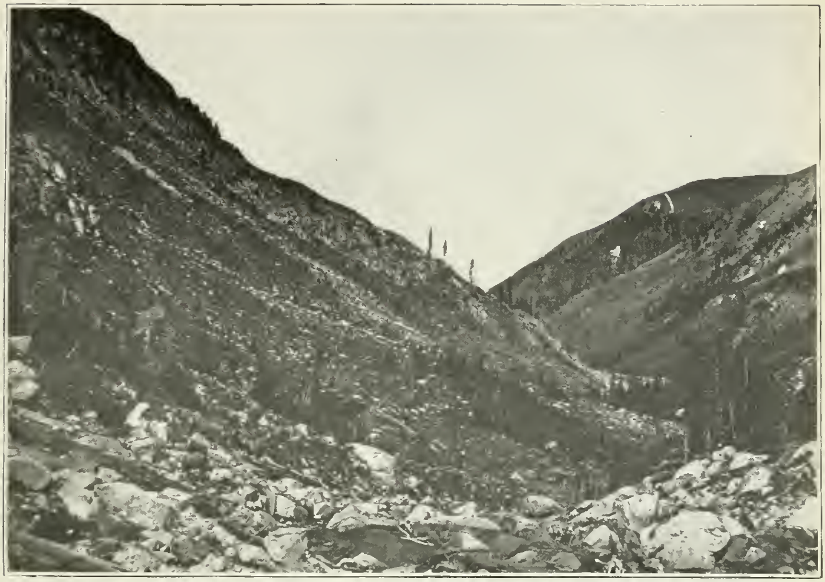


FIG. 1.—SHEEP GRAZING IN THE MOUNTAINS ABOVE WALLOWA LAKE, OREGON.

From a photograph by C. L. Shear.

FIG. 2.—IN THE FIELD. MESSRS. GRIFFITHS AND WILLIAMS IN NORTHERN WYOMING.

controlling their lands, there was a general struggle on the part of stockmen to make the most of the "free grass." The result was a rapid destruction of many of the best grasses by overstocking. The more valuable grasses being gradually destroyed, their places were occupied by more or less worthless annual species, as well as weeds, cacti, and mesquite. On account of the importance of the problems and the interest in them which has been shown by the stockmen, considerable field work has been done in Texas by the Division.

WORK DONE.

Mr. J. G. Smith made a special study of the forage problems of Texas and New Mexico. In 1897 he visited some thirty places in this region and made a careful study of the ranges and the grazing industry. Information was also secured by correspondence with cattle and sheep owners in the State of Texas. These inquiries were directed chiefly to ascertaining the present carrying capacity of the ranges and the amount of increase or decrease in carrying capacity that has taken place during the last twenty-five years. The results of Mr. Smith's work were embodied in Division Bulletin No. 16, "Grazing Problems in the Southwest and how to meet them." This report contains a very thorough account of past and present conditions of the Texas range lands; also the methods which have been and are being followed by stockmen, and the results. The very great decrease in the carrying capacity of the range is pointed out and the reasons clearly indicated. Aside from the destruction of the grasses by overstocking there is a great amount of injury done by animal pests, especially prairie dogs and jack rabbits. These pests were formerly controlled chiefly by their natural enemies, the gray wolves and coyotes, which have been killed by stockmen on account of their destruction of sheep and young cattle. These animals can, however, be controlled without great difficulty if the proper steps are taken. Poisoning has proven to be very effective. The whole section of land upon which the range-improvement experiments of the Division were located at Abilene was entirely rid of prairie dogs in a very short time in this way. The amount of grass destroyed by these animals is enormous. The prairie dogs practically exterminate all the grass in the vicinity of their burrows. The better grasses thus destroyed are replaced by inferior species which have much less feeding value. The rapid increase of the prickly pear (*Opuntia engelmanni*) is discussed and also means of destroying it. Fire is said to be the only remedy which is effective in fighting this plant. The mesquite bean (*Prosopis juliflora*) which we have just referred to as rapidly spreading over the country can scarcely be looked upon as an entirely undesirable intruder. It produces a great abundance of fruit. The pods which are filled with a sweetish, palatable pulp, are greedily eaten by cattle and horses, and are regarded as very nutritious. The fallen leaves are also said to be devoured by stock when forage is scarce. Besides the feed produced by this plant it also furnishes protection for stock during severe winter storms. On the other hand these mesquite bean groves furnish protection for various noxious weeds and shrubs. They also interfere with the development of the better grasses, which will not thrive in the shade.

In the more arid portions of New Mexico and Arizona there can be no question of the great value and importance of the mesquite bean (*Prosopis* sp.). Its relation to the forage problem here is indirect, but its influence on the general welfare of the country can scarcely be overestimated. In the valleys of the larger streams, as the Santa Cruz in the vicinity of Tucson, the prevailing species grows abundantly along the river and also extends in a small form far back from the river. The trees in the immediate vicinity of the river grow to large size. The timber has, however, been very largely destroyed by cutting it for fuel, and if the present practice of cutting all the available plants for this purpose is continued it will not be long before this valuable heritage will be destroyed. Efforts should be made to prevent further devastation of this valuable plant. The accompanying illustration shows the method followed in cutting such trees (Pl. XIX, fig. 2). The stumps are cut very high, and as the plant possesses great vegetative power and vitality, large numbers of strong shoots arise from the stumps and, growing with great rapidity, soon produce a considerable amount of fuel, so that successive cuttings are made in this way at intervals of a few years.

Mr. Smith points out the great need of practical and scientific measures being used in order to restore and protect the natural grazing lands, and discusses the various methods which give promise of success. The great advantage of alternation in pasturing is particularly mentioned. It has been shown that resting a pasture for a period, especially at the time of seed production, results in great improvement by giving the grass an opportunity to recuperate and to produce a crop of seed. In this connection we may quote the following:

> A rest of two or three months during the growing season in early spring would enable the early grasses to ripen and shed their seeds, thus perpetuating the species. After the seed had fallen the cattle could be turned on the grass for two or three months and again transferred to a fresh pasture. In the same way autumn and winter pastures can be secured.

The other means of range improvements which have been so successfully tried at several places are described. The method and advantage of making stack silage when there is a scarcity of feed are given. The desirability of providing water, either in the form of tanks or wells, so that the stock will not be required to travel long distances, and thus tend to the destruction of the grasses on the areas in the

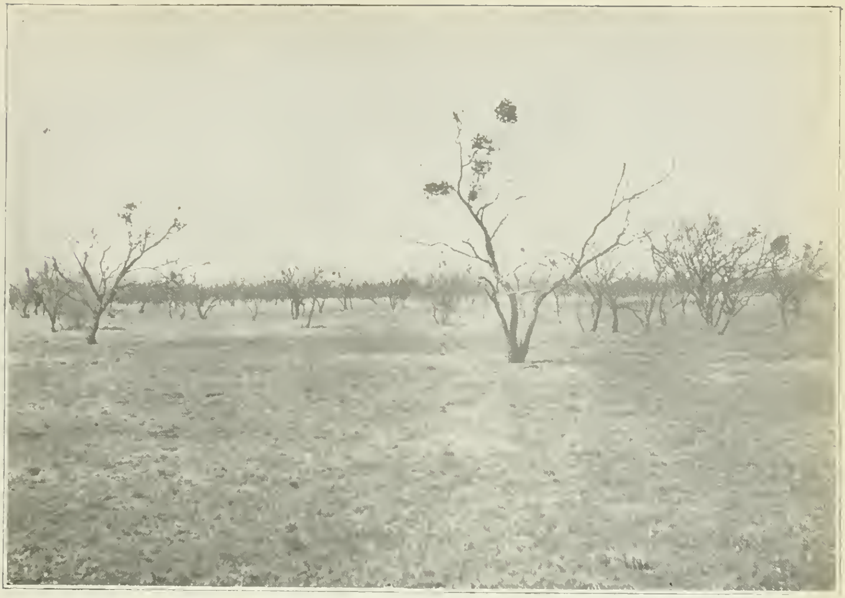


FIG. 1.—RANGE NEAR ABILENE, TEX., WHERE IMPROVEMENT EXPERIMENTS WERE CONDUCTED, SHOWING CHARACTERISTIC GROWTH OF MESQUITE BEAN (PROSOPIS JULIFLORA).

From a photograph by C. L. Shear.

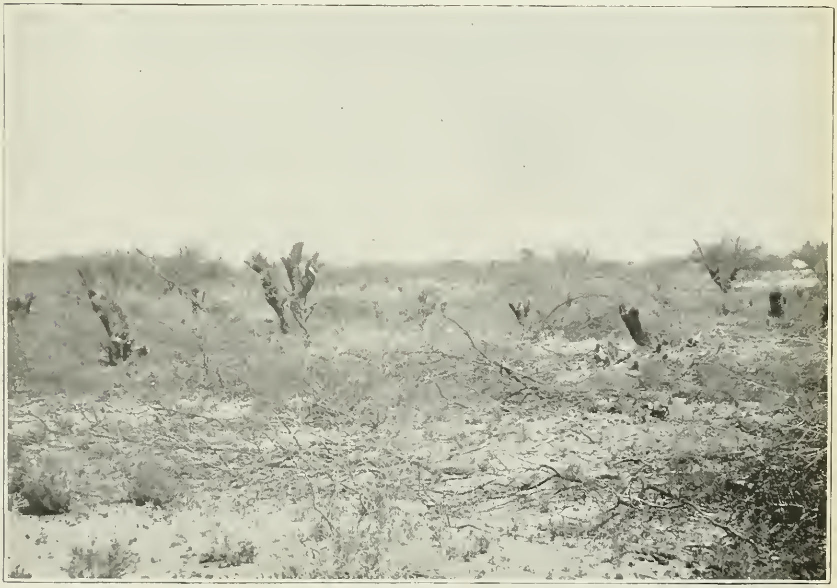


FIG. 2.—VIEW IN THE SANTA CRUZ VALLEY NEAR TUCSON, ARIZ., SHOWING THE MANNER IN WHICH THE MESQUITE BEAN (PROSOPIS SP.) IS BEING CUT.

From a photograph by D. Griffiths.

immediate vicinity of watering places, is urged. Following the discussion of the above subjects, the grazing regions in Texas and New Mexico are taken up and described. The characteristics of the prominent grasses and forage plants are given, with special reference to the more important species and their value. Finally, the relation of land laws to range improvement is considered, and the necessity for some method of control and management of the public grazing lands of the West is pointed out. An estimate is made that an increase of at least $25,000,000 would result from the improvement of the ranges even to the extent of 25 per cent, which improvement has been demonstrated to be easily possible.

Mr. C. C. Georgeson, Mr. T. A. Williams, Mr. H. L. Bentley, and the writer have also done field work in Texas. Mr. Georgeson visited Texas in 1898 for the special purpose of selecting lands and arranging for experiments in range improvement. He visited Abilene and Channing, planning and inaugurating the work at both places. Mr. Williams did some field work in Texas in the spring of 1900. He visited the experiment station at College Station and also the range-improvement experiments at Abilene and Channing. Mr. Bentley, in connection with his duties as special agent in charge of the grass station at Abilene, has done considerable field work and made collections of seeds, roots, and specimens. His chief duty, however, has been the carrying on of the experiments in range improvement which were undertaken three years ago on a section of worn-out pasture land situated near Abilene. As a result of Mr. Bentley's work and experience in Texas he prepared Farmers' Bulletin No. 72, on "Cattle Ranges of the Southwest," in which the various problems are discussed in a condensed and non-technical manner. The various means to be used in the renovation and improvement of the ranges are discussed and clearly indicated. There is also a list of the promising grasses and forage plants native of the Southwest, with illustrations and descriptions of many of them. This bulletin has been in great demand and has done much to arouse interest in the subject. Mr. Bentley has also written a report upon the grasses and forage plants of central Texas, which was published as Bulletin No. 10 of this division. This bulletin covers much the same ground as the one just referred to, going into more detail, however, on some points and giving a much more complete list of the forage plants. It contains many valuable notes regarding the native species and indicates which are most likely to prove valuable under cultivation. It scarcely comes within the province of this bulletin to discuss the experimental work carried on at Abilene, as Mr. Bentley is now preparing a full report upon this work for publication. It may, however, be well to state that it has been demonstrated that disk harrowing of worn-out pasture land each spring for three successive seasons has doubled, in the estimation of three competent disinterested stockmen, the carrying capacity of the range. The carrying capacity of the range at the beginning of the experiment was estimated by the judges to be one head of stock to 16 acres. Stock was kept on the land on this basis for the next season, when it was estimated that the carrying capacity was 1 to 10. Stocking was continued for the next year at that rate, and in the same way until the close of the third year, with the results given above. Partial results of this work have already been published. In Division Circular No. 8 Mr. J. G. Smith gave an outline of the work as planned and inaugurated. In circular No. 23 Mr. Bentley described the progress of the experiments during the first two years.

In New Mexico and Arizona the most unfavorable conditions are to be met with. A great portion of these Territories lies within what is known as the Great Basin, and over considerable areas real desert conditions prevail. The annual precipitation, while reaching in a single limited area as high as 20 inches, is, over most of these Territories, between 10 and 15 inches, while in southwestern Arizona and southeastern California there is an extensive region having an average rainfall of 5 inches or even less (see map 8). It will be readily seen that where the amount of rainfall is so small as that indicated the question of maintaining grasses and forage plants is a most difficult one. Notwithstanding these untoward conditions a considerable number of good grasses and forage plants have succeeded in surviving the struggle for existence here and have become adapted to the environment. We learn from the accounts of early explorers that large areas of excellent grass lands were formerly found in this country, especially in the valleys of the rivers. Our knowledge, however, of the ranges of these two Territories as a whole is, even at present, quite limited. Many portions of the country have never been visited by anyone who has given any special attention to the grasses and forage plants. The first work carried on by the Division in this section was done by Mr. C. R. Orcutt, who spent about three months here—from February to May—in 1896, leaving San Diego, Cal., going eastward to the San Felipe Valley, thence to the Colorado Desert, and across the Mojave Desert to the Colorado River. From here he went to Kingman, Congress, Phoenix, Tempe, Mesa, Maricopa, Tucson, Benson, and Bowie, thence across southern New Mexico by way of Deming to El Paso. From El Paso he went northward up the Rio Grande to Albuquerque, and from there westward by way of the Atlantic and Pacific Railroad across New Mexico and Arizona. The report of this work has not been published. The season during which this work was done was most unfavorable for studying the forage conditions of this country. The reason for this will appear more evident after an examination of the average rainfall for each month in the year. The distribution of the rainfall here is quite different from that of any other

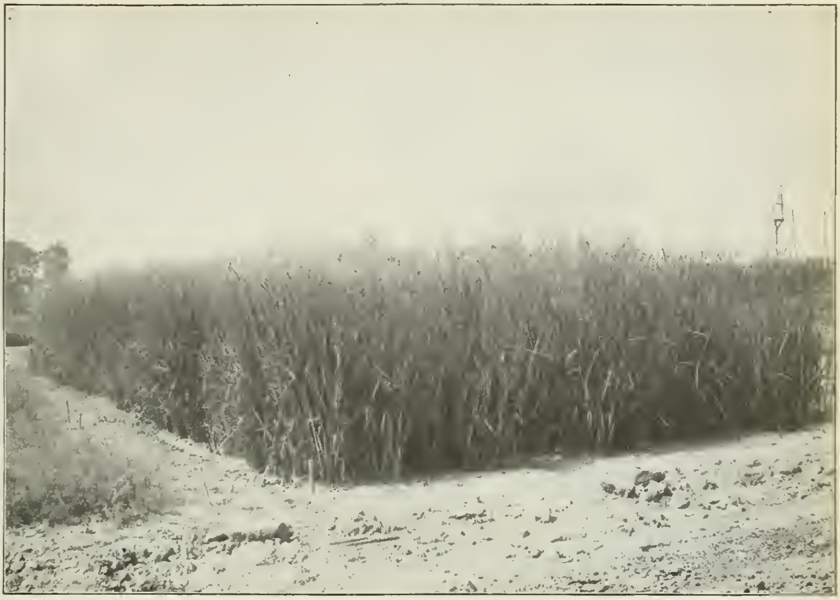


FIG. 1.—BULBOUS PANIC-GRASS, OR TURNIP GRASS, (PANICUM BULBOSUM). GROWN ON POTOMAC FLATS, WASHINGTON, D. C., FROM NEW MEXICAN SEED.

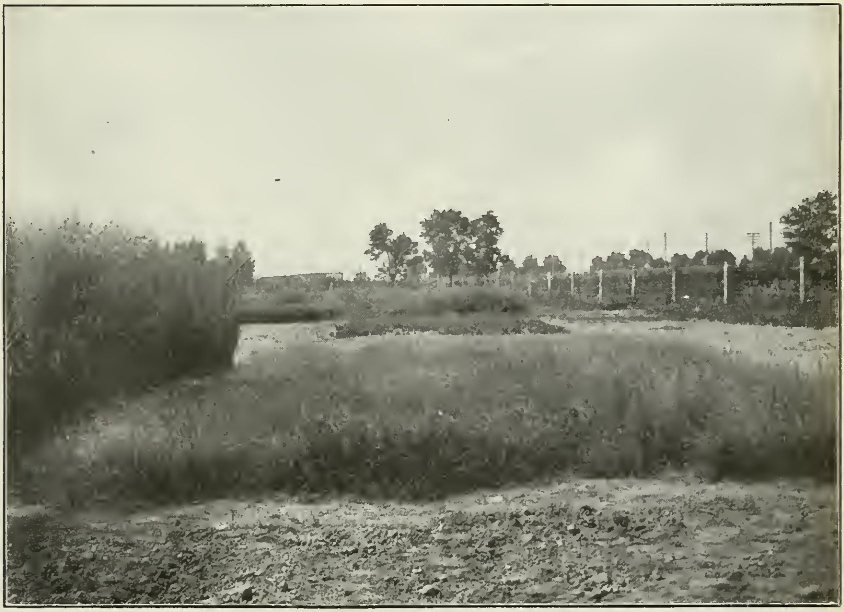


FIG. 2.—CURLY MESQUITE (HILARIA CENCHROIDES). GROWN ON POTOMAC FLATS, WASHINGTON, D. C.

portion of the United States, from 15 to 25 per cent of the annual precipitation occurring during July and August, the smallest amounts occurring in May and June, the water supply rapidly decreasing during the late winter and spring months. As a result of this the grasses and forage plants are at their best during the autumn.

Mr. Orcutt, however, secured a considerable amount of information from the stockmen and ranchmen regarding the grasses and range conditions. Mr. J. G. Smith, in connection with his work in Texas, which has already been referred to, also spent some time in New Mexico, particularly in the Pecos Valley and about Silver City in the southwestern part of the Territory. Mr. Williams also spent a short time in New Mexico in the spring of 1900 and visited Tucson, Ariz. The special purpose of this trip being to arrange for cooperative work with the experiment stations, very little opportunity was afforded for the investigation of the ranges. The results of Mr. Williams's work are published in Circular No. 8, Office of the Secretary. The particular problems in each State and Territory visited were discussed in this paper. The great need of undertaking some work looking to the improvement of the ranges and the introduction and cultivation of hardy forage plants in these two Territories was pointed out, and arrangements were made with the Arizona and New Mexico experiment stations to carry on investigations along these lines. These experiments have already been undertaken, but have not progressed far enough at present to produce any decided results.

During the autumn of 1900 Dr. David Griffiths, special field agent of the Division, was detailed to Arizona to look after the cooperative work just referred to, and also to make a collection of seeds of the native grasses and forage plants. Dr. Griffiths spent several weeks at this work and succeeded in obtaining large quantities of seed of some of the best of the native grasses and other forage plants. He also procured a considerable number of specimens, a list of which has recently been published in Circular No. 32 of this Division. The seed secured by him were used chiefly in carrying on experiments in Arizona and New Mexico, with a view to determining the possibilities and behavior of these plants under cultivation. Mr. James K. Metcalfe, who lives in the vicinity of Silver City, N. Mex., although not officially connected with the Division, is very much interested in the propagation of the native forage plants, and has done much valuable work in this direction. Through his aid the Division has been able to secure quantities of seed of a number of very valuable native forage plants. Of these we may mention particularly the bulbous panic grass (*Panicum bulbosum*). The accompanying illustration (Pl. XX, fig. 1.) gives an idea of the behavior of this plant under cultivation. The illustration shows a plat of this grass grown on the Department grounds on the Potomac Flats. The chief value of this plant lies in its great ability to endure drought. It also tolerates a considerable amount of alkali in the soil. It has been grown successfully for several years by Mr. Metcalfe at his ranch, and the Division is making special effort to introduce it into cultivation at various points in the southwest. It produces large crops of excellent hay as well as pasturage. Mr. Metcalfe was also the first to call attention to a native bean (*Phaseolus retusus*), which has been called in his honor "Metcalfe's bean." This plant produces excellent forage and is well adapted to withstand the arid conditions of the southwest. Quantities of seed of mountain brome (*Bromus polyanthus paniculatus*), Fendler's blue grass (*Poa fendleriana*), sprangle top (*Leptochloa dubia*), and a variety of Canadian rye-grass (*Elymus canadensis*) are some of the other important species which have been secured through Mr. Metcalfe's assistance.

Besides the work referred to above, the writer spent several weeks in this region during March and April of this year. The condition of the range in the vicinity of Abilene, Tex.; Mesilla Park, N. Mex., and Tucson, Ariz., was investigated. As already remarked, at this season of the year the range is in the most unfavorable condition for study, as most of the grasses have been eaten down or, in the case of annual species, passed away. An examination of the range at this time will, however, reveal the basal portion, at least, of the perennial grasses, if any are present, so that one can secure some idea of the possibilities of the ranges at a more favorable season of the year. The greater part of the range lands that were examined, especially those in the valleys and on the mesa, were almost devoid of grass vegetation. The ranges have been so heavily overstocked that the greater portion of the better perennial grasses have been entirely destroyed. This is particularly true of those portions of the range situated within easy distance of a more or less permanent water supply. Owing to the very scant and uncertain supply of water over large areas it has been impossible to graze stock for a sufficient period to destroy the grasses. The constant herding of stock in the vicinity of watering places has resulted in many cases in almost total destruction and abandonment of those ranges. The accompanying illustration will give an idea of the amount of forage present at this season of the year on such a range (Pl. XXI, fig. 1). Aside from a few species of annual weeds, which start up in the spring, there is practically no vegetation except the ever-present creosote bush and cacti. Most of these annual weeds are very small and of but little value. There is but one or two that is of sufficient importance to receive any serious consideration. These are species of plantain (*Plantago fastigiata* Morris) (Pl. XXII, fig. 1*a*), and another closely related species. These are small weedy annuals which would be regarded as worthless in almost any other region, but are of value here as being practically the only plants furnishing pasturage over vast areas during this season of the year. The difficulties of range improve-

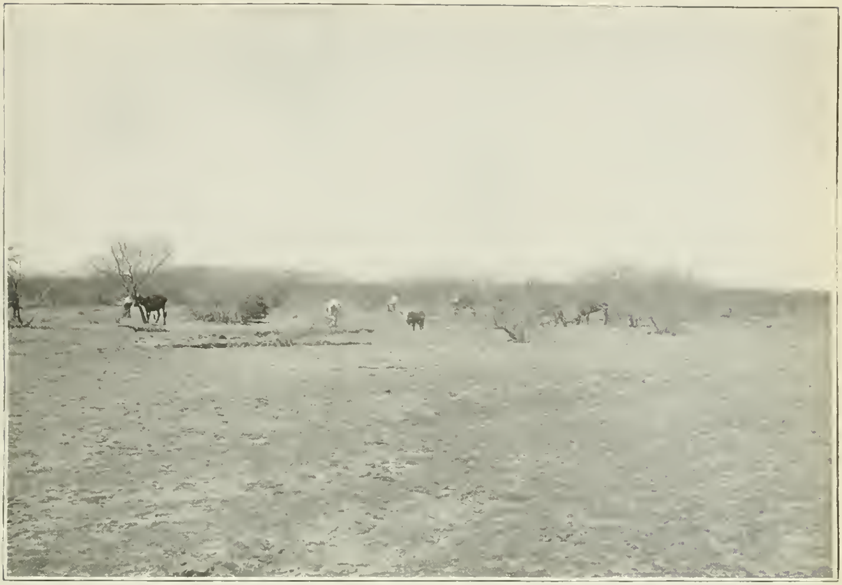


FIG. 1.—THE RANGE, 25 MILES SOUTHEAST OF TUCSON, ARIZ., SHOWING ITS CONDITION EARLY IN APRIL, 1901. ONLY A FEW SMALL, SCATTERED ANNUAL WEEDS PRESENT.

From a photograph by D. Griffiths.

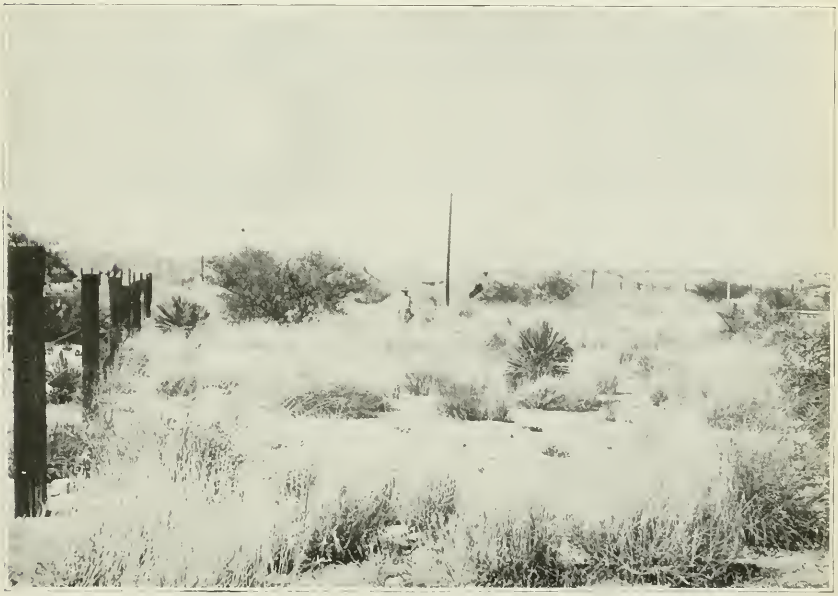


FIG. 2.—ALONG THE RIGHT OF WAY OF THE RAILROAD NEAR BENSON, ARIZ., SHOWING THE CONDITION OF THE GRASS UNDER PROTECTION.

From a photograph by D. Griffiths.

ment under such conditions will be readily recognized, as the range can not be recovered except by seeding. The methods of resting and disking have little hope of success here, as the grasses having been practically destroyed, none are left to reseed the land.

Of course, the condition of affairs described above represents the extreme. We are told, however, that there are extensive areas throughout these territories where the ranges are in the same condition. The effect upon the country of this denuding of the ranges is not restricted to the stock-growing industries, but affects the whole future of the country. One of the most serious immediate results is the erosion which follows the removal of vegetation from the surface. This erosion is so rapid and so great as to be almost beyond belief to one who has not actually observed it. The scanty rainfall, which usually comes in torrents, runs rapidly away over the bare surface of the soil, flowing through and rapidly eroding every shallow depression, so that it becomes only a matter of a few years when a cow-path or a wagon track forms an arroya several feet wide and deep. We had pointed out to us by reliable observers examples of erosion of this sort which have been produced within the past six or eight years. The accompanying illustrations show the results of nine years of this erosion in the vicinity of Tucson (Pl. XXIII). Besides the injuries caused by erosion are those resulting from floods and the deposition of the great amount of soil which is carried down by the streams. It will be seen from this that aside from the desirability of covering these barren lands with vegetation for forage purposes, there is still a greater necessity of covering them in order to conserve the rainfall and prevent this destructive erosion. However discouraging the case may appear, we do not regard it as hopeless.

The first and most important step looking toward the improvement and restoration of the public grazing lands is the control of these lands in such a manner as to make it to the advantage of the stockmen to improve the range rather than to devastate and destroy it, as is the tendency at the present time. This is the question of most fundamental importance, for no matter what temporary improvement may be brought about it can not be made lasting without there is some means of protecting the range from overstocking. The resources of this region, so far as native grasses and forage plants are concerned, are great, and if properly conserved and cared for will be found to meet, for the greater part, the needs of the country.

Several species of mesquite (*Hilaria* spp.) are common and furnish a considerable percentage of the pasturage on the range, particularly on the mesas. Curly mesquite (*Hilaria cenchroides*) (Pl. XX, fig. 2.) is one of the most excellent grazing grasses in the southwest. It is a so-called "short grass," forming a dense turf, spreading by means of runners and producing an abundance of very nutritious forage. It is in habit much like buffalo grass and blue grama grass, and replaces those species largely in western Texas and New Mexico. The black mesquite or black grama (*Hilaria mutica*), also called "gietta" in New Mexico and Arizona, is a very important species and one of great value in this region. *Hilaria rigida*, stiff mesquite, is also called "gietta." It is a rather coarse, harsh grass, growing in bunches, usually about 2 feet high; being able to survive the most arid conditions it is of especial value, as it is almost the only forage occurring in some places. It is not a grass that would appeal to the fastidious tastes of stock accustomed to the tender grasses of moister regions, but stock accustomed to this region eat it with avidity. It is a very nutritious grass and makes a very large growth immediately after a slight rainfall. Mr. Orcutt mentions that it is said to cause death to horses and cattle in case of stock just taken from alfalfa, but injury to range cattle from this cause has not been reported. Perhaps next in importance to the mesquite grasses are the grama grasses (*Bouteloua* spp.). *Bouteloua eriopoda*, woolly-foot grama, is one of the most valuable range grasses in this region, especially in southern Arizona, New Mexico, and Texas. It is a perennial, very hardy and nutritious, and is worthy of cultivation. Several other grama grasses are of more or less importance here. The blue grama, which is such an important grass on the ranges farther east, is not so abundant here. It occurs, however, in the northern part of this region, and is of great value wherever found, though not adapted to endure the extreme conditions of heat and drought to be met with in many parts of this country. Six weeks' grama (*Bouteloua aristidoides*) is an annual species which has assumed considerable importance since the destruction of the better perennial grasses (Pl. XXIV). It springs up immediately after the summer rains, growing very rapidly, as its name indicates, and producing considerable feed during the autumn. Low grama (*Bouteloua polystachya*) is another one of the so-called six weeks' grasses furnishing considerable forage in many places immediately after the rainy season of this region. Quite a number of other species of grama grasses occur, but are less abundant and important than the ones already mentioned. The triple-awn grasses (*Aristida* spp.) are also of considerable importance. They tend to spread and replace the better turf-forming grasses, which have been destroyed. When young they are quite readily eaten by stock, but when they have reached maturity they are avoided by stock unless driven to them by want of better feed. Several species of *Muhlenbergia* also furnish some feed in the foothills and canyons. A number of species of *Sporobolus* ("saccaton") are of considerable importance in this region, especially *Sporobolus cryptandrus*, *Sporobolus airoides*, alkali fine top, and *Sporobolus wrightii* (Wright's saccaton). The latter species is an especially robust and luxuriant bunch grass, formerly found in large quantities on the river bottoms of southern Arizona.

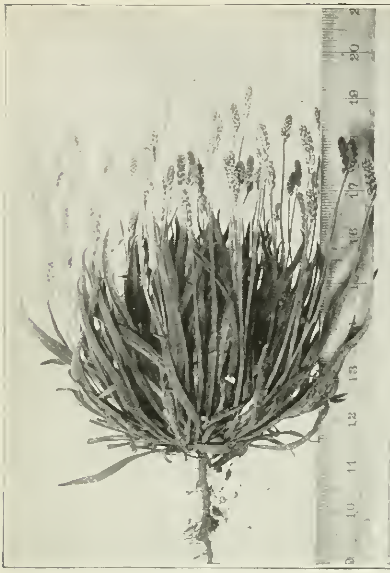


Fig. 1*a*.—Plantain (Plantago fastigiata Morris). A valuable Annual Forage Plant in southern Arizona.

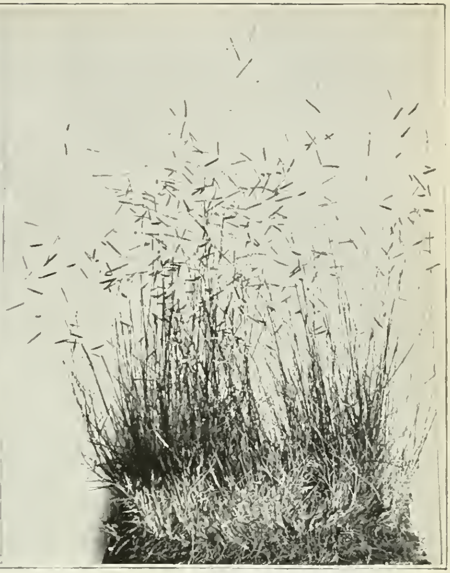


Fig. 1*b*.—Blue Grama (Bouteloua oligostachya) as it grows in Arizona.

From photographs by D. Griffiths.

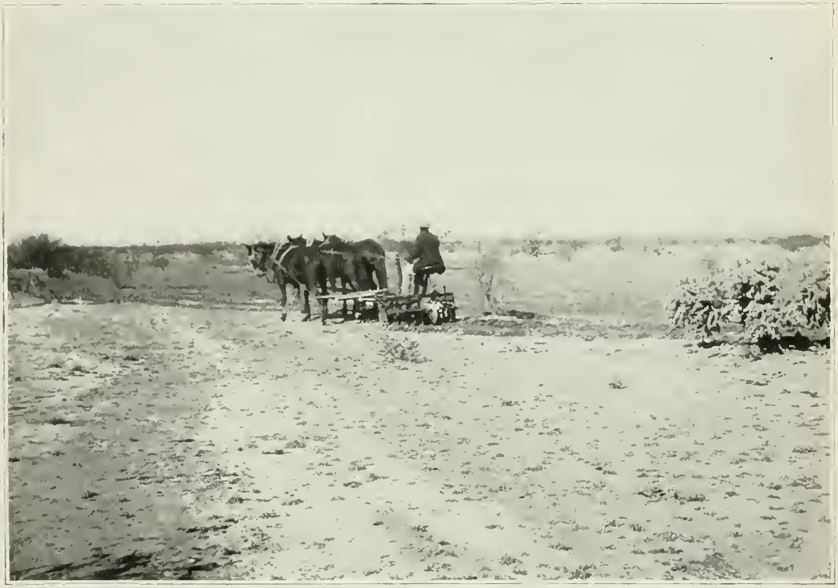


Fig. 2.—Range improvement Experiment, Tucson, Ariz., showing the Condition of the Pasture and the Method of Disk Harrowing.

From a photograph by D. Griffiths.

It is very coarse and rank, and would probably not be touched by stock where more tender and succulent grasses were to be found, but here, where there may be no alternative between it and the thorny cacti to sustain life, it is devoured. The accompanying illustration (Pl. XXV, fig. 2) shows some of this grass after it has been grazed. The wool grass (*Pappophorum vaginatum*), sprangle top (*Leptochloa dubia*), blunt panic grass (*Panicum obtusum*), *Chloris elegans* and feather beard grass (*Andropogon torreyanus*) are also species of considerable importance. Fendler's blue grass (*Poa fendleriana*), sometimes locally called mutton grass, is a valuable species, occurring in the foothills and mountains and furnishing palatable and nutritious feed. During certain seasons of the year, and in some locations, plants other than grasses form the most important portion of the grazing. Some of these plants are of considerable value and worthy of serious investigation with a view of introducing them into cultivation. Others are eaten only as a last resort when stock are threatened with starvation, and could scarcely be classified as forage plants. To this last category we may refer the various species of spiny cacti, with which the heads of animals are occasionally found covered during periods of extreme drought and scarcity of food. Species of yucca, especially *Yucca elata*, are sometimes browsed in cases of scarcity of better food. The shad scale (*Atriplex canescens*) and winter fat (*Eurotia lanata*) are valuable forage plants which grow naturally here, and may perhaps be cultivated to advantage. The accompanying illustration shows the shad scale grazed and ungrazed (Pl. XXVI).

The above are some of the most important species of native grasses and forage plants, and where the rainfall of the region must be depended upon for the supply of moisture, experience indicates that it is to these native plants that we should look for species to grow for hay and pasture. The only reasonable hope for success with introduced species is in the case of those which are brought from regions where much the same climatic conditions prevail. Plants introduced from Central Australia and other high arid or desert regions may, perhaps, be grown with success, as for instance, the Australian saltbush. Species of spineless cacti might profitably be experimented with here and also investigations carried on in the selection and breeding of spineless forms of the native species. In regard to the restoration of the range, where the better grasses have been practically destroyed, it will be necessary to break the soil by harrowing, preferably with a disk harrow, and sowing seed of the native species. This sowing should be done about the time of the commencement of the summer rainy season in order that the young plants may have the full benefit of the moisture supply. Stock should, of course, be kept from these seeded areas until the grasses have had an opportunity to become firmly established. Wherever possible supplies of water should be provided at points which would not necessitate long journeys on the part of stock to secure drink. By proper treatment ranges which still have a sufficient supply of grass left to reseed them may be reclaimed by disking and allowing a period of rest or by alternating periods of pasture and rest, allowing the grasses to produce seed. Where there are facilities for irrigation there is little trouble in the selection of good forage plants. Alfalfa can be successfully grown in most portions of the region. In the Santa Cruz Valley barley is grown extensively for green feed and hay. Alfalfa is also an important crop here. The different varieties of nonsaccharine sorghums and also the millets may be profitably produced under irrigation.

THE PACIFIC COAST.

CONDITIONS AND PROBLEMS.

The Pacific Coast region, as discussed here, will be confined to the country lying west of the Cascade and Coast Range mountains. There is considerable variation in the climatic conditions at various points in this region. For instance, near the southern part of California the annual rainfall averages 10 inches, while on the coast of northwestern Washington there is a small area having an annual rainfall of 100 inches. From San Francisco northward, however, the differences are not so great, the annual precipitation varying from 30 to 100 inches. The rainy season in this region is during the winter, the greatest rainfall occurring in December and January, with a rapid decrease of precipitation as the spring and summer advances, so that during June, July, and August there is little and sometimes no rain. It will be noticed that over the greater portion of this region there is a sufficient moisture supply to meet the needs of most forage plants, so that it is only in very limited areas that arid conditions are to be met with. The real range lands here are quite restricted as compared with those in the Great Basin and Rocky Mountain region, as there are extensive forest areas all along the coast. There are, however, frequent openings in the woodlands which are termed "prairies," and in many places open or brush-covered range lands in the foothills and mountains.

The dairying industry is perhaps the most important one in this region. Stock growing, however, assumes considerable importance at certain points in California and Oregon.

The control of the shifting sands, which are menacing and in many places destroying the agricultural lands at certain points along the coast, is a matter of great importance.

WORK DONE.

Considerable work remains to be done here, as there has been opportunity thus far to do but a limited amount of investigation.

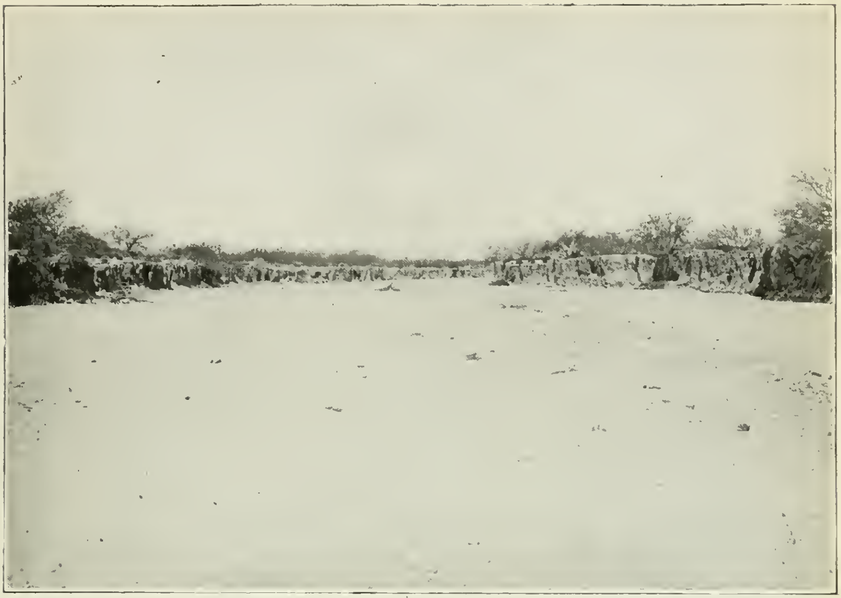


FIG. 1.—A "WASH" NEAR TUCSON, ARIZ. THE RESULT OF BUT NINE YEARS EROSION.
From a photograph by D. Griffiths.

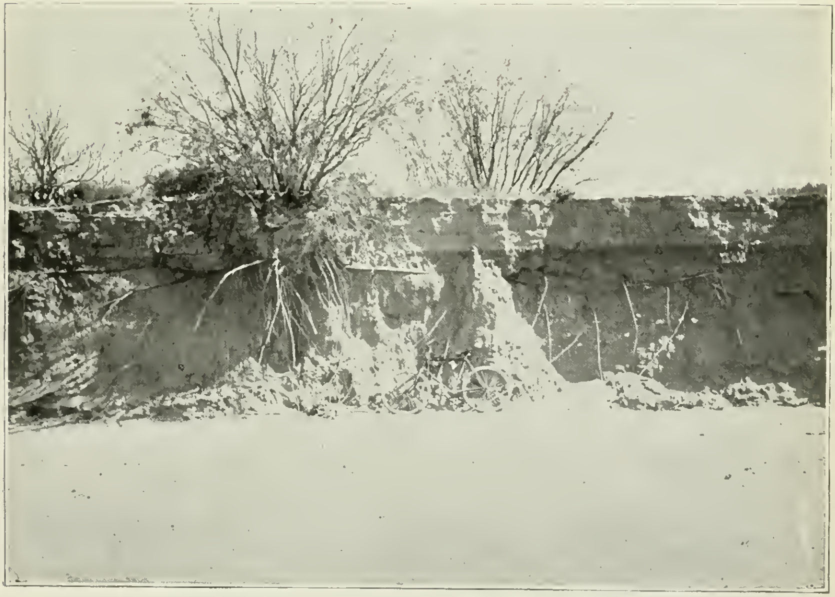
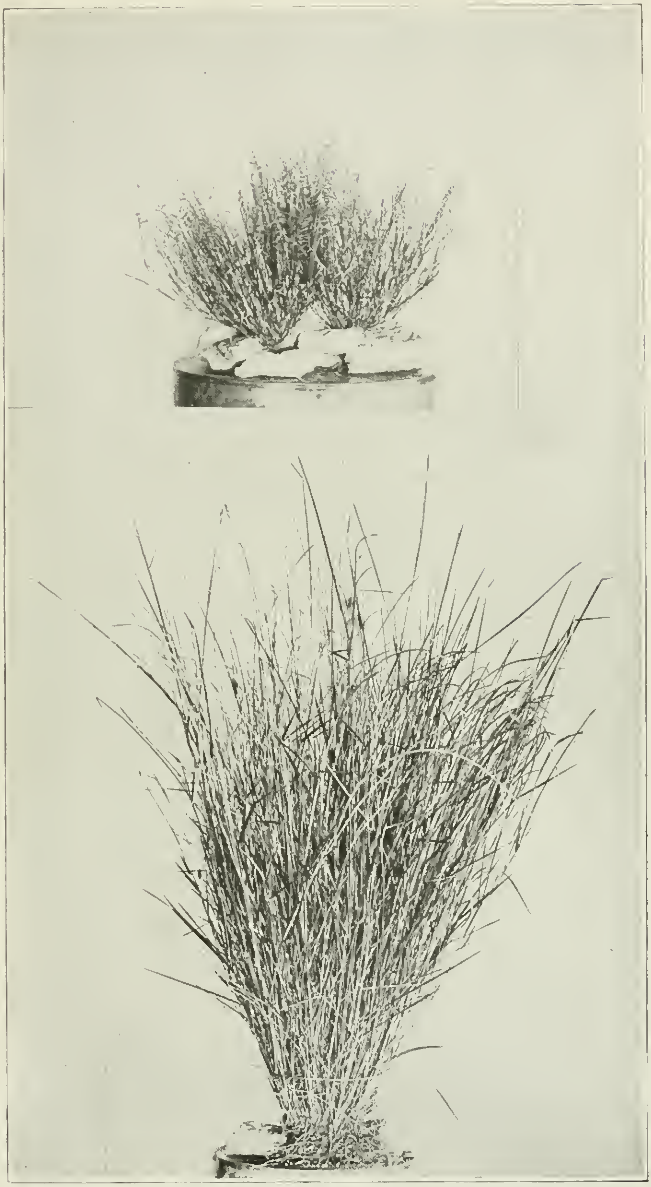


FIG. 2.—THE SIDE OF THE SAME "WASH," SHOWING THE DEPTH.
From a photograph by D. Griffiths.

Mr. Leckenby has spent considerable time in the study of the sand dunes on the Oregon coast at the mouth of the Columbia River, and south as far as Seaside. Professor Scribner has also investigated the sand dunes in this same vicinity and at various points in California, especially at Los Angeles, San Francisco, and points northward. The most thorough and extended investigations in this region have been made in northwestern California, by Mr. J. Burt Davy, special agent of the Division. His investigations covered the region included in the counties of Lake, Mendocino, Humboldt, Trinity, Del Norte, and the western part of Siskiyou. Mr. Davy made a very careful and thorough study of the conditions and problems in this region, and has prepared a comprehensive report of the whole subject, which is nearly ready for the press. The writer has also done some field work in this region. Work was done in connection with Mr. Leckenby and Professor Scribner at Seaside and Gearhart where the sand dunes and the native sand binders were studied and quantities of seed collected. Work was also done in the vicinity of Portland and McMinnville, also at San Francisco and vicinity. Very little investigation of the ranges of this region has been made, except by Mr. Davy. He reports the ranges of northwestern California greatly deteriorated on account of overstocking and injudicious methods of grazing. This has been carried on to such an extent that most of the forage at present found on the range consists of introduced plants which have taken possession of the land since the destruction of the native grasses and forage plants. Fortunately these introduced species have some forage value. They are chiefly soft chess (*Bromus hordeaceus*), alfilaria (*Erodium* spp.), and wild oats (*Avena*, probably *A. barbata*). The wild oats, however, is said to be much less common than formerly. Of the native grasses species of wild rye (*Elymus* spp.), brome grasses (*Bromus* spp.), hair grasses (*Deschampsia* spp.) wild-oat grass (*Danthonia* sp.), prairie June grass (*Kœleria* sp.), and fescues (*Festuca* spp.) are now to be found only in protected situations, though they were probably, as Mr. Davy points out, much more abundant formerly. Several native species of clover (*Trifolium* spp.) are also valuable for forage. The restoration of the ranges here, as elsewhere, must depend upon proper and continuous treatment. Where the native grasses have been practically exterminated seeding with some of these or with introduced species adapted to the conditions will probably be necessary. In other instances, allowing the range a period of rest or alternate periods of grazing and rest, thus giving the plants an opportunity to produce seed, will produce beneficial results. Where dairying is carried on cultivated forage plants are depended on largely for grazing and hay. Oats and wheat are most extensively grown for hay. In western Oregon considerable chess (*Bromus secalinus*) is grown for hay, also the ray grasses (*Lolium* spp.). while velvet grass (*Holcus lanatus*) is abundant and has taken possession of many meadows. Some timothy, redtop, and a little alfalfa have also been grown. Permanent hay meadows would no doubt be an advantage, however, and there is reason to believe that there would be little difficulty in securing cultivated grasses which would be successful here. Meadow oat grass (*Arrhenatherum elatius*), orchard grass (*Dactylis glomerata*), meadow fescue (*Festuca pratensis*), and red clover (*Trifolium pratense*) can be successfully grown according to Mr. Davy. With so large a number of available grasses and forage plants to choose from there should be little difficulty in providing pasture the year round, and this seems to be one of the things most desirable in order to secure the greatest success for the dairying business. Soiling crops could no doubt also be grown to advantage.

Considerable work has been done in the study of the sand dunes and the study and collection of the native sand binders. Large quantities of seeds and roots of the native sand binders have been collected for distribution and transplanting. Seaside blue grass (Pl. XXVII, fig. 1) (*Poa macrantha*), which is abundant on the Oregon coast and which is very efficient in holding drifting sands, has been distributed to various places in the interior and on the Atlantic coast, where it is hoped that it may be successfully introduced. Sand rye-grass (*Elymus arenarius*) is also an excellent native sand binder. Big-head sedge (*Carex macrocephala*) is abundant on the Oregon coast at Seaside (Pl. XXVIII). This is a plant which spreads very rapidly by running rootstocks and performs very efficient service in holding the drifting sands. Roots and seeds of this plant have also been collected for use in experiments in other localities, where it is hoped that it may be successfully introduced. *Abronia latifolia* and lupines are also of considerable importance as sand binders and worthy of trial elsewhere.

No publication has yet been issued by the Division dealing specially with the work done in this region. Circular No. 22 on "Grass and Forage Plant Investigations on the Pacific coast," with the exception of a slight reference to sand-binding grasses, treated entirely of the work done east of the Cascade Mountains, which has already been referred to under the discussion of the Northwest. The results of Mr. Davy's work are nearly ready for publication, and as they will treat of the different problems very thoroughly and in detail it will not be necessary for us to give more than the outline of the work which has already been given. The portions of this region lying between Seaside and the southern boundary of Oregon and extending from the coast to the mountains is in need of exploration and investigation, and will no doubt repay careful study. The dairying interests are particularly important here, and the value, abundance, and distribution of the native grasses and forage plants is little known.



THE UPPER PLANT, SIX WEEKS GRAMA (BOUTELOUA ARISTIDOIDES); THE LOWER, A DROP SEED (SPOROBOLUS CRYPTANDRUS STRICTUS); BOTH NATIVE ARIZONA GRASSES OF CONSIDERABLE IMPORTANCE.

From a photograph by D. Griffiths.

GENERAL SURVEY AND SUMMARY.

The field work already described includes investigations which have been carried on in 32 States and Territories. In many of these States the work has been extensive and thorough. As a result the actual conditions of the meadows and range lands have been ascertained; the various native forage plants have been collected and studied and their abundance, distribution, and relative value discovered. The forage plants cultivated in the various regions have also been studied and the capabilities of the regions for growing others not already grown have been in many instances determined. Special attention has been given to the causes of the deteriorated condition of the vast areas of grazing lands belonging to the public domain with a view to devising means for removing the causes and restoring the ranges to their original productiveness and carrying capacity. The particular problems calling for most immediate attention in each region have been determined and steps taken toward their solution. As a result of the knowledge thus gained the Division is able to recommend to farmers and stockmen in the various parts of the country the forage crops adapted to their conditions and special requirements, and also to carry on intelligently experiments with introduced forage plants likely to prove valuable in any particular region.

Not the least important results of these investigations has been the determination of the vast natural forage resources of the country. Our heritage in this respect has never been fully known and much less appreciated. In our search for grasses and forage plants to cultivate we have tried many from different parts of the world, while neglecting those all about us. There are growing within the bounds of the United States over one thousand species of grasses, and perhaps one hundred or more other plants of sufficient forage value to justify their investigation and cultivation. Of course, a great many of these grasses have little forage value, either on account of their scarcity, small size, or some quality which renders them unpalatable to stock. A large number of them are, however, of great value for hay and grazing purposes, and can probably not be surpassed by any in the world. Because they are native they have been too often not only neglected, but abused, and, in some cases, partially exterminated. It is certainly time we began to properly estimate and appreciate the great value of our native grasses and forage plants and take steps toward their conservation. Experiments have already shown that many of these most valuable grasses take kindly to cultivation and produce much larger quantities of hay and pasture when a little attention is given them. The buffalo grass, the grama grasses, blue grasses, the mesquites, the fescues, and the wheat and rye grasses, which furnish the bulk of the feed for the immense numbers of stock which roam over the public lands of the great West, are of inestimable value and could not be successfully replaced by any importations from foreign countries. To discover why this is true requires no great amount of research. These grasses have for ages grown under the prevailing unfavorable climatic conditions and have survived in the struggle for existence by reason of their having become adapted to these conditions. Judging from the wonderful feats which horticulturists have already performed in the selection and breeding of plants, there appears no reason why, by proper cultivation and selection, many of these native grasses should not be greatly improved, and in cases where they possess characteristics which tend to interfere with their successful cultivation, these may no doubt be eliminated. Some of these native grasses are at present excluded from becoming of great commercial importance on account of the difficulty of manipulating the seed. This difficulty is frequently the result of the presence of awns or hairs on the floral envelope enclosing the seed. These could, by careful selection and breeding, be gotten rid of. Hope for any great amount of success with introduced forage plants is only to be realized in case of those brought from regions whose climatic conditions are similar to ours. In all the field work special effort has been made to call the attention of stockmen and ranchmen to the value of the native grasses and to recommend means of perpetuating and increasing them. Investigations already carried on have demonstrated the possibility of restoring worn out range and pasture lands to nearly, if not quite, their original carrying capacity by entirely practical and economical methods of treatment in cases where the grasses have not been practically exterminated. Where there is still present a sufficient amount of good grass to produce seed there is a chance for restoring the range without great difficulty. Allowing the range a complete rest for a year or two produces results which astonish one who has never witnessed the experiment. Alternation in pasturing also produces very beneficial results, with less loss of grazing. In following this method pastures should be so arranged that the stock can be kept from certain areas for a sufficient length of time to allow the grasses to mature and scatter their seed, or to regain the vigor of their root system, which has been greatly injured by close grazing and trampling. Some of the best grazing grasses, as the blue grama, buffalo grass, and curly mesquite, reproduce most extensively by means of creeping rootstocks sent out by the plants, while others, as in the case of the bunch grasses, depend largely upon their seed for propagation. Alternation in pasturing gives the plants an opportunity to recuperate and regain their vigor. Another very efficient means of improvement is the disking of the range or pasture. The great advantage of this is that by the loosening of the soil the roots, which have been prevented from normal develment by the trampling of the stock and the lack of moisture supply,

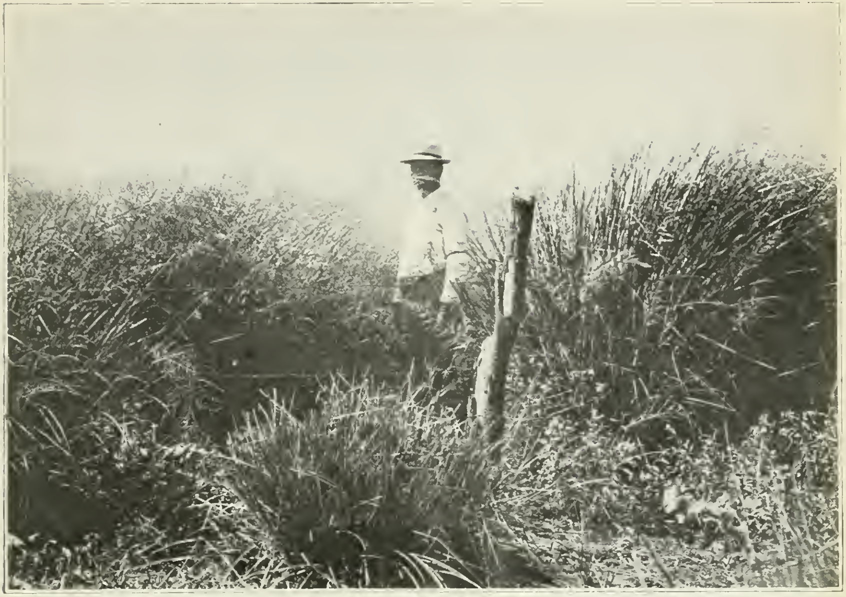


FIG. 1.—WRIGHT'S SACCATON (SPOROBOLUS WRIGHTII). IN THE SANTA CRUZ VALLEY, ARIZONA, SHOWING BUNCHES WHICH HAVE NOT BEEN GRAZED.

From a photograph by D. Griffiths.

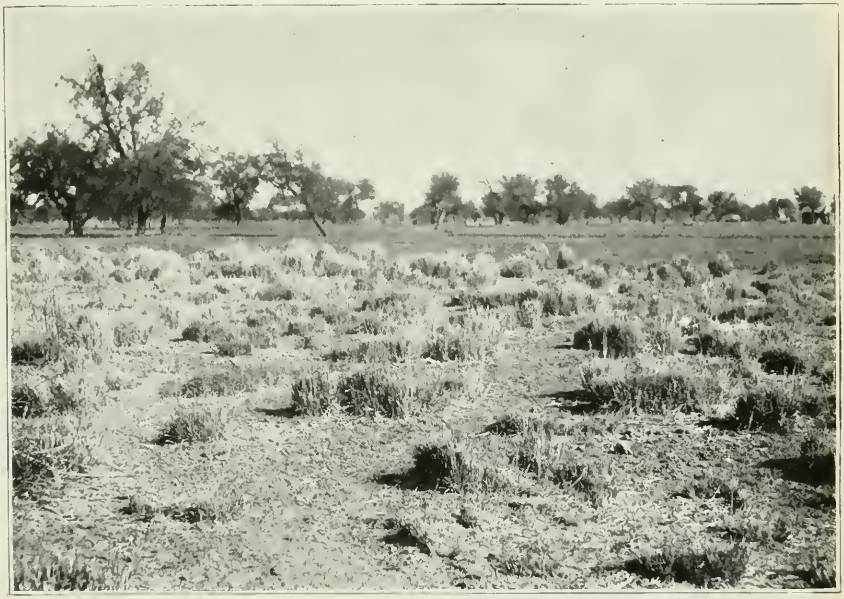


FIG. 2.—WRIGHT'S SACCATON, SHOWING ITS APPEARANCE AFTER BEING GRAZED. SAME LOCALITY

From a photograph by D. Griffiths.

are given a chance to grow freely. The breaking of the soil also gives a chance for the storm waters to be absorbed, instead of rapidly running away over the hard surface of the soil. That these methods are feasible and very successful has been thoroughly demonstrated by the work of the Division in Texas. In cases where the native grasses have been largely destroyed, in addition to the disking it will be best to sow seed of the native grasses on the disked areas. These can frequently be secured by collecting them from protected places, where the grasses have been allowed to produce seed. Along the right of way of railroads the native grasses frequently grow luxuriantly, and produce an abundance of seed. We believe it will not be long, however, before seed of the more important of our native grasses will be collected or grown in commercial quantities and be obtainable on the market.

FORAGE PLANTS FOR ALKALI SOILS.

A great deal of attention has been given to the question of grasses and forage plants adapted to growth on alkali soils. There are very extensive areas throughout the West over which the soil is so impregnated with mineral salts, especially those of sodium and magnesium, that the majority of cultivated forage plants can not be grown. There are, however, a considerable number of native forage plants which have become adapted to the alkali soils and are able to grow upon them. Investigations along this line have shown that some of these native plants are of sufficient importance as forage plants to justify attempts toward introducing them into cultivation. This is particularly true of a number of the native saltbushes which are able to grow in soils containing large percentages of alkali and also to withstand excessive drought. Considerable quantities of seed of eight different species of native saltbushes were secured the past season and besides being grown on the experimental grounds at Washington they have been distributed to the experiment stations of the West for cultivation and trial. These plants are particularly valuable for sheep grazing. They are also relished by other stock and furnish a large amount of food at times when no other is available. Several other species of saltbush which are native of the alkali regions of the interior of Australia have also been introduced and grown on the alkali lands of the West and Southwest. The Division has distributed considerable quantities of seed of these saltbushes, especially the Australian saltbush (*Atriplex semibaccata*). This has been experimented with sufficiently to demonstrate its adaptability to cultivation in the warmer portions of the West and Southwest. Winter fat (*Eurotia lanata*) is another valuable forage plant which flourishes in alkali soils from Montana to Arizona. A number of grasses of considerable value also grow upon these alkali soils. Those which grow where the greatest amount of alkali is present are, however, not palatable to stock and are eaten by them only when better forage is not available. Quite a number of the better native grasses tolerate a considerable amount of alkali and by cultivation and selection could no doubt be made to withstand greater quantities.

SAND AND SOIL BINDERS.

As mentioned in discussing the various regions, considerable work has been done in investigating the sand and soil binding plants of the country. It has been found that we have a considerable number of excellect species of great value for this purpose. Besides the beach grass (*Ammophila arenaria*), sand rye grass (*Elymus arenarius*), bitter panic grass (*Panicum amarum*), creeping panic grass (*Panicum repens*), and the sea oats (*Uniola paniculata*) of the Atlantic and Gulf coasts, we have seaside blue grass (*Poa macrantha*) and several rye grasses on the Pacific coast and along the Columbia River. There are found growing in the interior also several important sand and soil binders. Redfield's grass (*Redfieldia flexuosa*) is one of the best of those found growing in the interior. It is a native of the sand hills of western Nebraska and Kansas. Indian millet (*Oryzopsis cuspidata*), sand grass (*Calamovilfa longifolia*), reed grass (*Phragmites vulgaris*), reed canary grass (*Phalaris arundinacea*), big cord grass (*Spartina cynosuroides*), blunt panic grass (*Panicum obtusum*), Johnson grass (*Andropogon halepensis*), and Vasey's needle grass (*Stipa vaseyi*) are important soil binders adapted to use on railway or river embankments, along ditches, or in other places where it is desirable to prevent the washing of the soil. Large quantities of seeds and roots of many of these species have been collected and distributed to various places for propagation and testing. In the case of the sand binders it has been found best to transplant the roots, as the sands frequently shift so rapidly that plants grown from seed are destroyed before they have made sufficient growth to be effective.

SPECIMENS SECURED.

An attempt has been made in connection with the field work to secure herbarium specimens of all the grasses and forage plants met with, in order that material may be at hand for study and comparison, for illustrative purposes, and for use in identifying the plants which are constantly being sent from different parts of the country. About 25,000 specimens have been secured by the Division force and field agents. Of these, about 9,000 have been added to the collection of the Department and the greater portion of the remainder distributed in exchange to the larger herbaria of the universities, botanical gardens, and experiment stations, not only in this country but throughout the world. In this way it has been possible to secure material, both specimens and seeds, of a great many foreign grasses and forage plants.

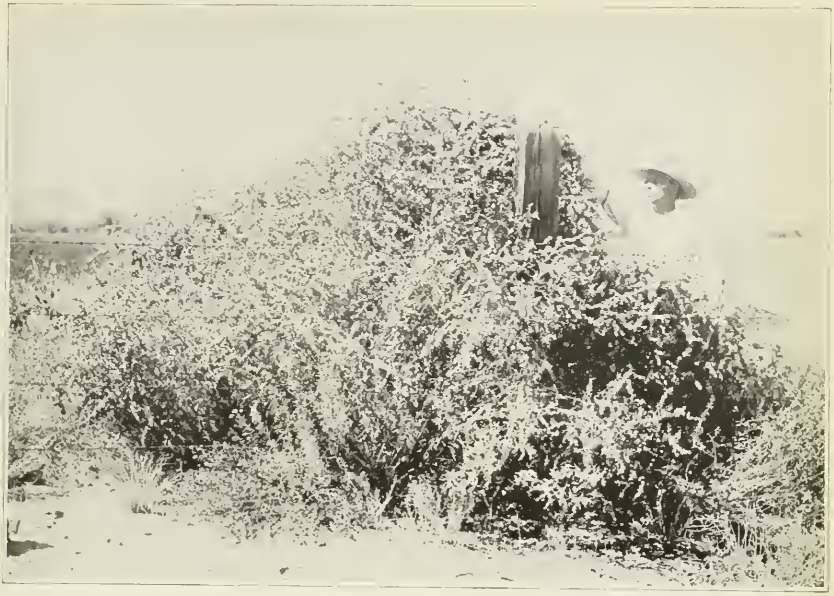


FIG. 1.—SHAD SCALE (ATRIPLEX CANESCENS). PLANT PROTECTED FROM GRAZING, NEAR TUCSON, ARIZ.

From a photograph by D. Griffiths.

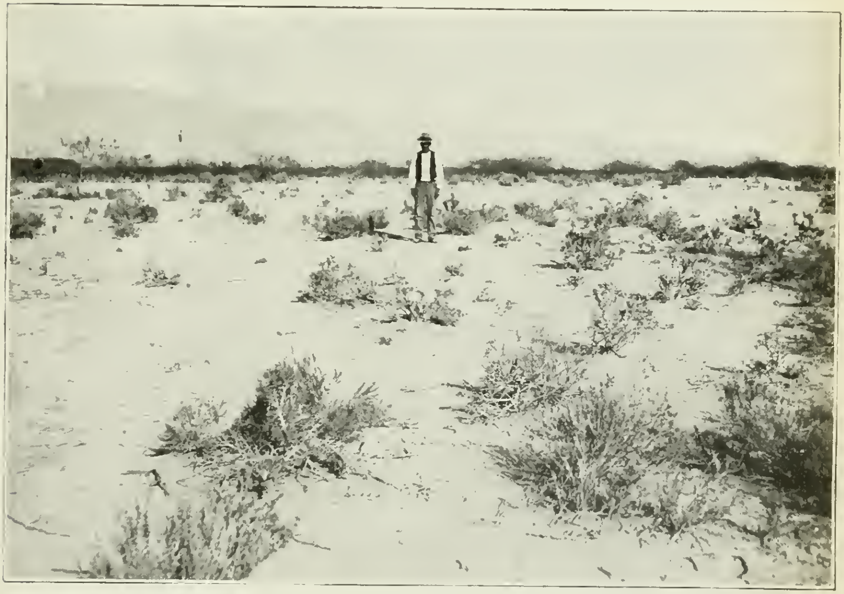


FIG. 2.—SHAD SCALE (ATRIPLEX CANESCENS). PLANTS IN THE SAME LOCALITY NEARLY DESTROYED BY OVERSTOCKING.

From a photograph by D. Griffiths.

The study of these collections has resulted in the discovery of about 75 species of grasses which had not before been described. The various bulletins containing studies on American grasses have been based in great part upon the study of these large collections. In fact, nearly all the publications of the Division are based either directly or indirectly upon the field work which has been done.

Besides the collection of specimens, a collection of seeds of the native grasses has been made a very important feature of the field work, especially during the past two seasons. Recognizing the great value and importance of the native forage products, special efforts have been made to show the possibilities in the way of cultivation and to encourage the production of seed by seedsmen. This will no doubt be done as soon as there is a sufficient demand for them. During the past season over four tons of seed of native grasses and forage plants were collected and distributed. As these seed were nearly all collected by hand, the amount of labor required may be appreciated. Besides the specimens and seeds, roots and sheaves have also been collected in quantity. In some cases it is impracticable to secure seed of a desirable plant, and in such cases roots were taken up and forwarded to various points for transplanting. Buffalo grass (*Bulbilis dactyloides*), Bermuda grass (*Cynodon dactylon*), Texas blue grass (*Poa arachnifera*), and others have been established and propagated at various places in this way. The sheaves have proven very useful for purposes of illustration and exhibition. A large collection was on exhibition at the Paris Exposition, and a collection has also been sent to the Pan-American Exposition. Another very interesting and important result of the work has been the securing of photographs illustrating all features of the work. In the neighborhood of a thousand negatives have thus been obtained. These are invaluable for illustrating the various publications of the Division. From them a series of lantern slides has also been made for use in connection with lectures and various features of the Division's work.

CONTROL OF GRAZING LANDS.

In the following paragraphs a brief account is given of the various methods adopted in other countries for controlling the public grazing lands. These may prove helpful in devising some method of controlling our own grazing lands.

THE AUSTRALIAN SYSTEMS.

An examination of the methods pursued by the different Australian colonies in the management of their grazing lands may be of interest and benefit in this connection. There are vast portions of the interior of Australia where, on account of an insufficient supply of moisture, grazing is the chief industry. The conditions that prevail are in many respects similar to those obtaining throughout portions of our semiarid West. During the early settlement and development of the Australian colonies attempts were made to restrict the occupation of the country to certain areas adjoining the coast settlements. As the population increased, however, and the development of the stock industry began, there was a gradual pushing beyond these boundaries into the vast interior. As the government at this time had made no provision for granting right or title to these lands, the pioneer stockmen, who were the first to occupy the country, were termed "squatters." Soon after the occupation of the grazing lands by squatters, difficulties arose similar to those which at present confront us. The government, however, began to devise means for disposing of these lands. The laws, however, were at first based upon an insufficient knowledge of the country and its requirements and did not always produce the desired results. At first in New South Wales plans were made for selling the land at a nominal figure. This was soon stopped, however, as the demand for land became so great and the alienation of large areas of the most valuable tracts was so rapid and led to so many troubles that the plan was abandoned. Selling lands at auction was also tried. These schemes proved unpopular and unsuccessful, largely because the land had not been properly classified. Later, various plans for renting the grazing lands were tried. Their first efforts along this line were not always successful, and frequently led to fraud and injustice. While they do not yet claim to have secured an entirely satisfactory arrangement, still the present method is far superior to no method, and the experiments and experiences which they have had may be of great value to us. The grazing lands are rented at present in areas ranging from 2,560 to 10,240 acres for a period of fifteen years. The tenant is obliged to make improvements, such as fences or some other equivalent. At the expiration of this lease an extension may be granted if it is considered by the land board that the range has been benefited by the occupation. The rents are appraised by local land boards every five years. Preference is given actual residents in the lease of areas lying near their property. Land of inferior character may be leased at auction.

In Victoria a plan of licensing the grazing of stock at a certain rate per head was tried. This, however, did not prove satisfactory, and later the plan was changed and provision made for renting the range lands, according to their estimated value based upon their carrying capacity, computed at the rate of 8d. per annum for sheep and 2s. per head for cattle. Tracts as at present leased vary in size from 7,500 to 40,000 acres. No person is allowed to hold more than one tract. If more than one application is made for renting the land, it is put up at auction. No lessee is allowed to assign or transfer his lease without

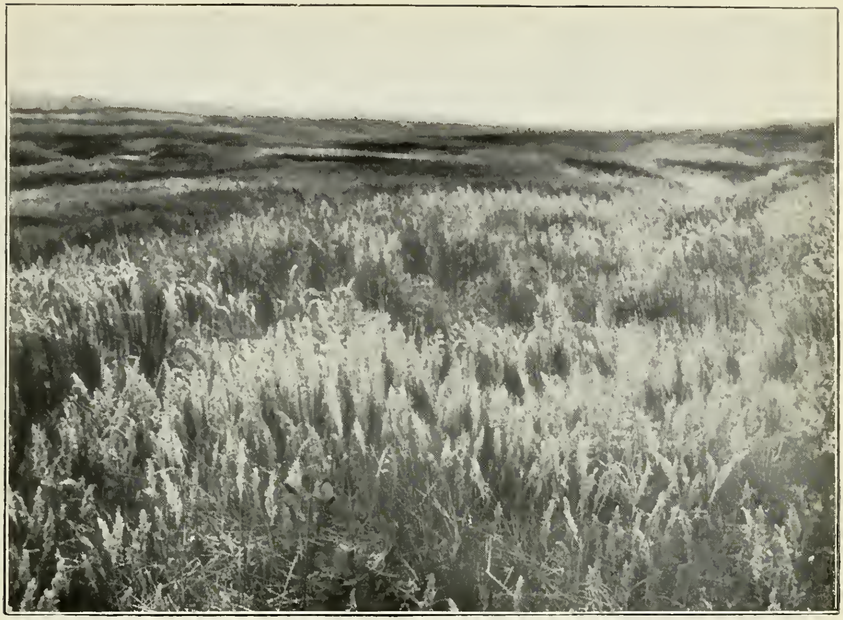


FIG. 1.—SEASIDE BLUE GRASS (POA MACRANTHA).

From a photograph taken near Morrison, Oregon, by A. B. Leckenby, 1899.

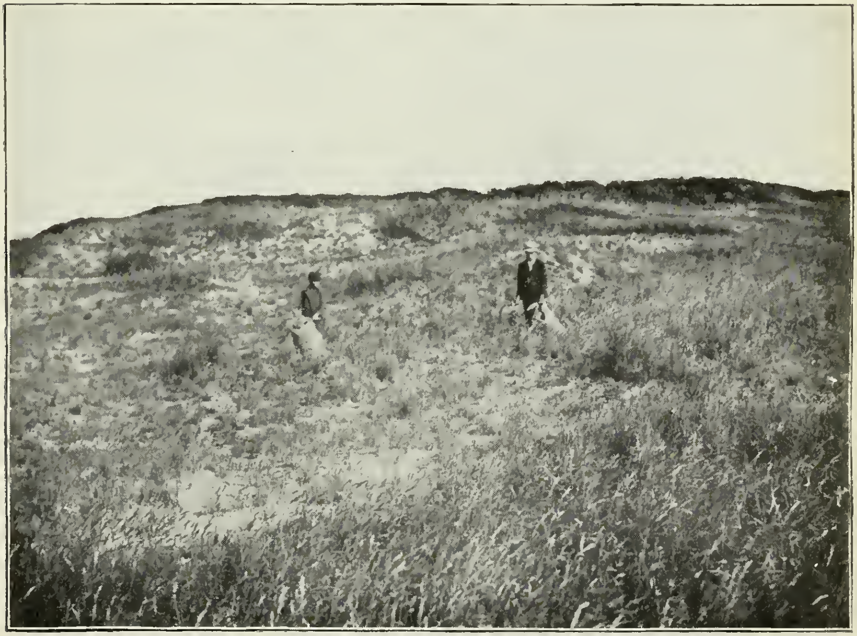


FIG. 2.—COLLECTING SEED OF SEASIDE BLUE GRASS NEAR MORRISON, OREGON.

From a photograph by A. B. Leckenby, 1899.

consent from the department having charge of the land. At present in Victoria the rental for the grazing lands is fixed by "valuers." The system as at present in operation in Victoria is said to have produced very satisfactory results.

In Queensland and Western Australia various methods similar to those tried in the other colonies have been in vogue at different times. Here as elsewhere the present plans are some modification of the lease system, the plans for the alienation of the land having been abandoned, as they have proved detrimental to the development and prosperity of the country.

CANADA.

Though the grazing lands of the Dominion are far less extensive and important than ours, still provision has been made for their control. The governor in council has authority to grant leases of unoccupied Dominion lands from time to time to any person or persons for such a term of years and at such a rent as may be deemed expedient, with the condition that if it is thought best by the Minister of the Interior to offer the land for settlement he may, on giving the lessee two years' notice, cancel the lease at any time during its term.

TEXAS.[1]

The public lands within the State of Texas are entirely under her control. The commissioner of the general land office of the State has charge of the land. The public lands are carefully and skillfully classified and valued and plats prepared. Provision is made for the sale of grazing lands, not to exceed four sections to the same settler, at a price not less than $1 per acre, but the purchaser must settle on one of the sections. The grazing lands are leased at not less than 3 cents per acre, the period of lease to be not more than five years. Formerly the possible period of lease was ten years. The person occupying the land has preference in re-leasing. Land may be advertised and let to the highest responsible bidder in such quantities and under such regulations as the commissioner may think best. Notwithstanding objections on the part of some to different phases of the Texas lease system, it seems to have proven fairly successful, and is certainly much preferable to no system at all.

STATE SCHOOL LANDS AND RAILROAD LANDS.

In Colorado and other States the lease system has been applied to the school lands with very satisfactory results. The large tracts of land granted to the transcontinental railways, including in some instances a strip 40 miles wide and covering large areas of grazing land, are being leased by the corporations. It will be seen from the foregoing that different countries, States, and corporations having possession of grazing lands have found leasing to be the most practical and advantageous method of controlling them.

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[1] We are indebted to Mr. J. J. Terrell, acting commissioner of the general land office of Texas, for the above facts.

The true measure of the success of any system of control is not the amount of income in dollars and cents derived each year, but the results to the grazing lands themselves and the general development and prosperity of the country. The funds arising from the lease of the lands might be very profitably used in developing the irrigation resources of the semiarid region.

SUGGESTIONS FOR FURTHER WORK.

As will be noted from the preceding account, the greatest and most important investigations of the Division are necessarily based upon field work. The various problems can not be studied successfully except under the natural conditions prevailing in the different regions. There are yet various phases of the work of the division, both scientific and economic, which require careful field observations and investigations. While from the work already done we are familiar with the condition of the ranges over considerable areas during certain seasons of the year, still it is desirable that a thorough knowledge of the conditions should be ascertained at different seasons. Investigations thus far have been carried on chiefly during the summer. In order, however, to get an adequate idea of the grazing lands, they should also be observed and studied during the spring and late autumn. An examination made during the most unfavorable season is apt to lead to an incorrect estimate of the capacity of the range, while an examination made when the range is at its best naturally leads to an error in the opposite direction.

The questions concerning the relation of grazing to the forests and water supply are still in need of considerable study, as conclusions based upon work carried on in one region may be entirely inapplicable to another. These problems are already being studied by the foresters and others interested in these subjects, but there is also need of careful work with special reference to the methods and manner of grazing these areas and the plants which furnish the forage. This work can no doubt be most economically and advantageously carried on in connection with the Division of Forestry. Aside from the special problems there are large areas of grazing lands in the West which have never been examined by our field workers. No work has been carried on by the Division in Nevada, and the greater portions of Arizona and New Mexico have never been studied. Little in the way of accurate observation has been done on the grazing lands and conditions in portions of California, Oregon, and Idaho. There are also special

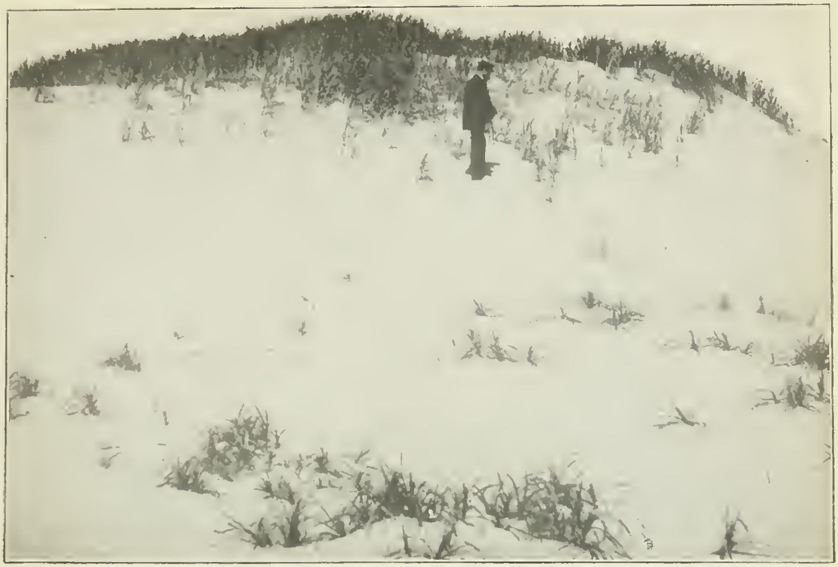

FIG. 1.—SAND DUNE ON THE PACIFIC COAST. SAND RYE GRASS (ELYMUS ARENARIUS) COVERING THE TOP OF THE DUNE AND BIG HEAD SEDGE IN THE FOREGROUND.

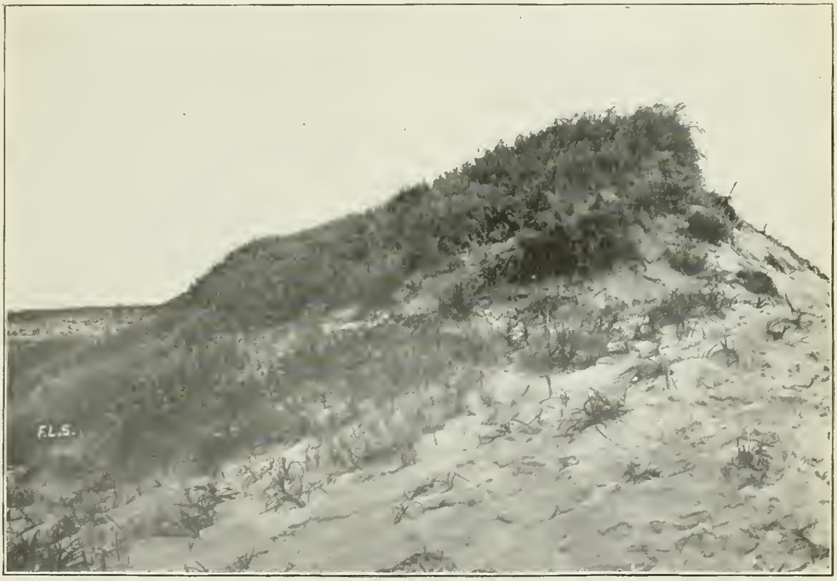

FIG. 2.—SAND DUNE HELD BY SEASIDE BLUE GRASS (POA MACRANTHA), NEAR SEASIDE, OREGON.

From a photograph by F. Lamson-Scribner, 1899.

problems in New England and the Southern and Central States which are in need of careful field study.

There is also need of a much more careful and accurate study of the various species of native grasses in the field. The dried specimens, which are prepared for the herbarium, are very valuable for study and comparison, but they do not retain all the characteristics which are necessary to a full and satisfactory knowledge of the plants. It is gradually becoming recognized by students of plants that in order to obtain a thorough and accurate knowledge of the species they must be studied in the living state, growing under natural conditions and in their natural environment. Descriptions of species in order to be accurate and have the greatest scientific value should be made from the living, growing plant *in situ*. Drawings and illustrations should also be made from the same material. Good photographs are also very valuable for illustrating the habits of growth of various species.

Notwithstanding the great amount of literature published and widely distributed each year by the Division there seems to be a large number of people who should naturally be interested in and benefited by the work done who are not reached by this means. A plan somewhat similar to that adopted by the Division of Forestry would, no doubt, greatly increase the usefulness of the work. This is the giving of lectures on questions relating to grasses and forage plants at the various points visited by field workers. These lectures or talks, illustrated by stereopticon views, would bring much more forcibly to the attention of the people the various problems and methods of dealing with them. Under the stimulus of such direct and individual contact much greater and more important and beneficial results would be secured. Direct assistance and advice in the solution of any of the problems which present themselves would be a great advantage and result in greatly widening the field of influence and the practical importance of the work. The more closely we come in contact with the people who are struggling with the various forage problems the greater benefit will be derived by both. This contact will also promote a mutual understanding which will lead to a better appreciation of the difficulties to be overcome and a more thorough sympathy and cooperation in the work.

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